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Fulton Vertical Coil Design Thermal Fluid Heaters

(Models FT-C & FT-S)

Installation, Operation and Maintenance Manual

Serial # _____

Model # _____

Fulton Order # _____

Sold To _____

Job Name _____

Date _____

Fulton Thermal Corp.
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Section 1

Section 1 – Safety Warnings & Precautions

Prior to shipment, the following tests are made to assure the customer the highest standards of manufacturing:

a) Material inspections
b) Manufacturing process inspections
c) ASME welding inspection
d) ASME hydrostatic test inspection
e) Electrical components inspection
f) Operating test
g) Final engineering inspection
h) Crating inspection

Rigging your heater into position should be handled by a competent rigger experienced in handling heavy equipment.

The customer should examine the heater for any damage, especially the refractories. **It is the responsibility of the installer to ensure all parts supplied with the heater are fitted in a correct and safe manner.**

Warning

Operating the heater beyond its design limits can damage the heater, it can also be dangerous. Do not operate the heater outside its limits. Do not try to upgrade the heater performance by unapproved modifications. Unapproved modifications can cause injury and damage. Contact your Fulton dealer before modifying the heater.

Warning

A defective heater can injure you or others. Do not operate a heater which is defective or has missing parts. Make sure that all maintenance procedures are completed before using the heater. Do not attempt repairs or any other maintenance work you do not understand. Obtain a Service Manual from Fulton or call a Fulton Service Engineer.

Warning

Thermal Fluid Heaters have high temperature surfaces, that if touched may cause serious burns. Only competent and qualified personnel should work on or in the locality of a thermal fluid heater and ancillary equipment. Always ensure the working area and floor are clear of potential hazards, work slowly and methodically.

WARNING: If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliances.

- **WHAT TO DO IF YOU SMELL GAS**

  - Do not try to light any appliance.
  - Do not touch any electrical switch; do not use any phone in your building.
  - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
  - If you cannot reach your gas supplier, call the fire department.

- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

For Your Safety

The following **WARNINGS**, **CAUTIONS** and **NOTES** appear in various chapters of this manual. They are repeated on these safety summary pages as an example and for emphasis.

- **WARNINGS** must be observed to prevent serious injury or death to personnel.
- **CAUTIONS** must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.
- **NOTES** must be observed for essential and effective operating procedures, conditions, and as a statement to be highlighted.

It is the responsibility and duty of all personnel involved in the operating and maintenance of this equipment to fully understand the **WARNINGS, CAUTIONS** and **NOTES** by which hazards are to be eliminated or reduced. Personnel must become familiar with all aspects of safety and equipment prior to operation or maintenance of the equipment.

Note

The installation of a barometric stack regulator is recommended at all installations.

Note

If the tank is located outdoors nitrogen is required.

Note

Non-code tanks cannot be pressurized over 15 psig.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through the vent connection on the combination dearetor/thermal buffer/expansion tank.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

Note

Low emissions burners for all models require 10 psi gas pressure.

Note

With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed four feet total.

Note

The system pump is not to be used to fill the system.

Caution

For reasons of safety, the hot exhaust gas duct and chimney must be insulated or shielded within the locality of the heater.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

Note

Do not run the pump before filling it with fluid.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

Warning

During a system boil out, it is imperative that all system legs or paths are open to flow to ensure no water is trapped in the system.

Warning

Never open a cool or unheated user leg of a system when the rest of the system is above 250°F.

Note

Do not open drain or vent valves during operation.

Note

If excessive amounts of thermal fluid is vented from the system, additional thermal fluid may be required in the system.

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

Note

Start-up technician should verify that all valves are opened prior to establishing flow and heat-up.

Note

If fluid or piping is added to the system the boil out procedure must be followed as water has to be introduced into the system.

Note

If the burner loses flame while driving to a point then:

- **Turn the main ON/OFF switch to OFF. Reset the loss of flame fault. Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light on the panel box door should go out.**
- **Adjust the air and gas servos for that point while the burner is off. Follow steps 28-29.**
- **Turn the main ON/OFF switch to ON.**

Note

As soon as a servo position is altered, the servo will move to that position. Only change servo settings by a maximum of 0.5° at a time before verifying combustion.

Caution

The heater emissions may not be correct after changing the servo motor. Verify the emissions throughout the range of modulation. If emissions are off, the servo motor can be adjusted by following the procedure in the Commissioning the Heater section of this manual.

Note

Use extreme caution to avoid contact with the cleaning solution.

Note

Refer to local regulations for disposal of caustic solution.

Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.

Note

Since unit lights at low fire, it may be necessary to increase high gas pressure setting or jumper contacts to allow unit to modulate to where modulation gas valve back pressure is lessened.

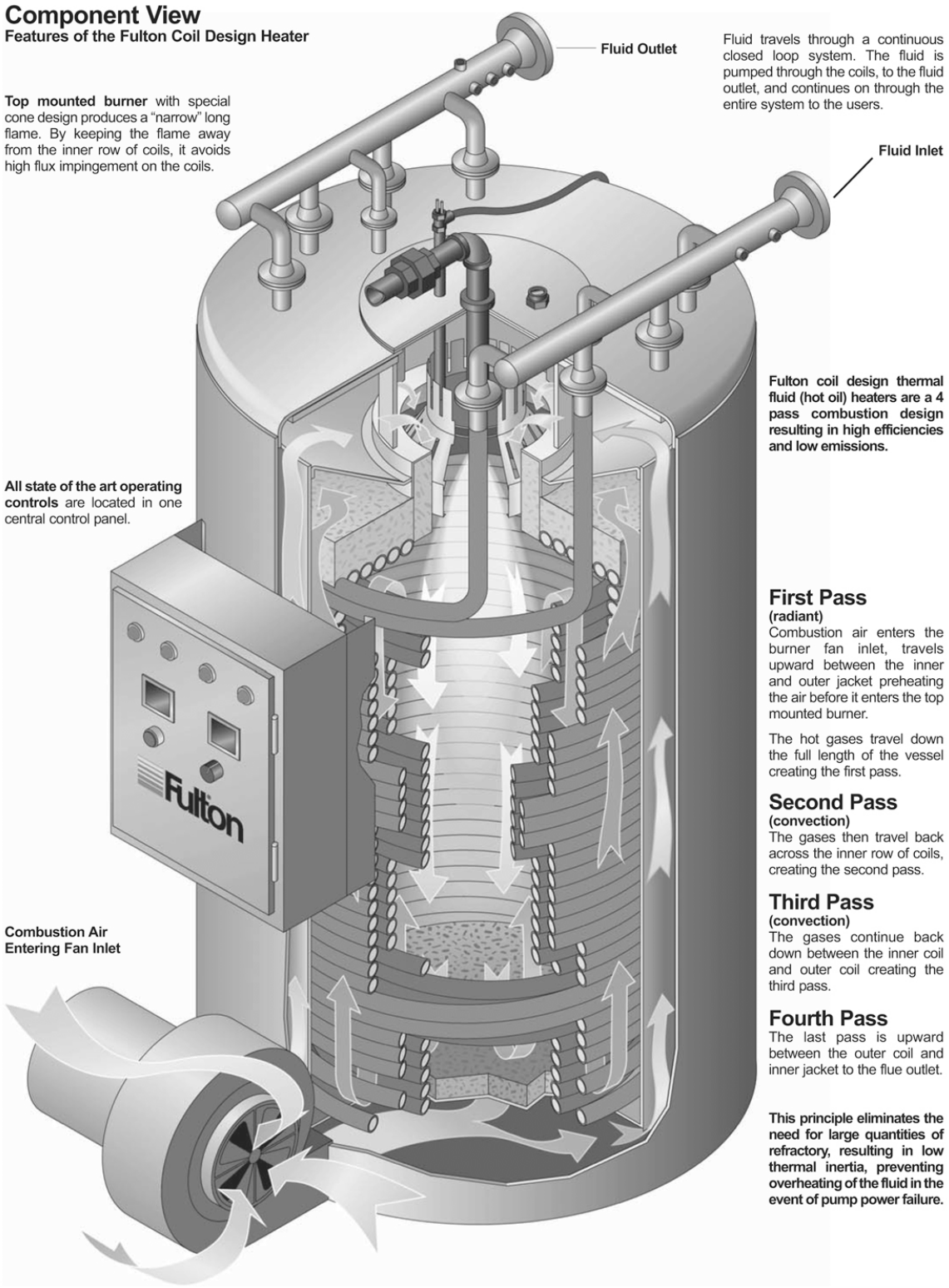
Note

Room temperature not to exceed 100^{o} F.

Section 2

Section 2 – Installation

1. Component View


Component View
Features of the Fulton Coil Design Heater
Fluid Outlet
Fluid travels through a continuous closed loop system. The fluid is pumped through the coils, to the fluid outlet, and continues on through the entire system to the users.
Top mounted burner with special cone design produces a "narrow" long flame. By keeping the flame away from the inner row of coils, it avoids high flux impingement on the coils.
Fluid Inlet
Fulton coil design thermal fluid (hot oil) heaters are a 4 pass combustion design resulting in high efficiencies and low emissions.
All state of the art operating controls are located in one central control panel.
Fulton
First Pass
(radiant)
Combustion air enters the burner fan inlet, travels upward between the inner and outer jacket preheating the air before it enters the top mounted burner.
The hot gases travel down the full length of the vessel creating the first pass.
Second Pass
(convection)
The gases then travel back across the inner row of coils, creating the second pass.
Third Pass
(convection)
The gases continue back down between the inner coil and outer coil creating the third pass.
Fourth Pass
The last pass is upward between the outer coil and inner jacket to the flue outlet.
Combustion Air Entering Fan Inlet
This principle eliminates the need for large quantities of refractory, resulting in low thermal inertia, preventing overheating of the fluid in the event of pump power failure.

2. Placement

a) Proper placement of your Fulton Thermal Fluid Heater is essential. Attention paid to the following points will save a great deal of difficulty in the future. Correct placement is the first step to trouble-free installation, operation and maintenance.

b) All Fulton Vertical Coil Design Heaters are shipped vertically and all units are crated for forklift transport. Once uncrated, all units with the exception of freestanding models FT-0080C, FT-0120C, FT-0160C and FT-0240C can be transported with a forklift.

c) These four models can only be lifted for unloading and moving by means of lifting lugs at the top of the heaters. If means of lifting are not available, rollers should be placed beneath the frame of the heater, and it should be guided to the position of where it is to be installed. Under no circumstances should weight be allowed to bear on the jacket, control panel or fan housing of any Fulton Thermal Fluid Heater.

d) All stand alone heaters can be moved via a crane utilizing the lifting lugs on top of the heater. The FT-0320C and larger stand alone heaters can also be moved using a fork lift. All skidded units can be moved with forklifts.

3. Location

a) Authorities with jurisdiction over any national or local codes which might be applicable to thermal fluid applications should be consulted before installations are made.

b) The heater should be located as close as possible to the place where the heat will be used in order to keep pipe work costs to a minimum.

c) A level, hard, non-combustible surface is required for a suitable base for mounting the unit. It is suggested that a four inch curb be installed completely around the unit. In the event of a large spill, this will help contain the fluid.

d) Approximations for the floor loading of each heater are given in the floor loadings table. Check building specifications for permissible floor loading.

e) The heater should be placed in a suitable heater house or well ventilated separate room through which personnel do not normally pass. This is not essential, but the layout should eliminate traffic in potentially hazardous areas. For instance, the service engineer or the operator should not have to pass exposed, hot pipe work to make adjustments to the heater controls.

f) Ventilation must be sufficient to maintain a building temperature of 100°F. or less and the panel box temperature must not exceed 125°F. Natural ventilation should be provided by means of grills at floor and ceiling level.

g) To burn fuel properly, the burner must have an adequate supply of air. The bottom vent should be sized to allow a minimum of 0.4 square inch of opening for every 1,000 BTU/hr. input of fuel (10 cm^2/1000 kcal/hr). The upper vent should be at least one third this size. See table for minimum make up air required and the recommended area of opening for each heater.

h) If positive forced ventilation is adopted, you must ensure that there will be no appreciable pressure variation in the heater room.

Note

The installation of a barometric stack regulator is recommended at all installations.

i) Artificial ventilation by extraction of air is not recommended. This method of ventilation can create a negative pressure in the building which will seriously affect combustion and proper operation of the stack. Please note that exhaust fans or similar equipment can create a down draft in the chimney or starve the burner's air supply. Either case may result in poor combustion or nuisance failures. A properly designed make-up air system in the heater room will preclude these possibilities and is required to maintain proper combustion.

j) In addition, an exhaust fan may draw products of combustion into the work environment creating a possible hazard to personnel.

k) It is essential that only fresh air be allowed to enter the combustion air system. Foreign substances, such as combustible volatiles and lint in the combustion system can create hazardous conditions.

Note

When calculating ventilation requirements, heat losses from the Fulton equipment (and other equipment) should be considered.

4. Approximate Floor Loadings

a) Free standing figures take the weight of the heater alone into consideration. Floor loadings for skid mounted units vary with configuration.

Model	Heater Only
FT-0080C	500 lbs/ft2
FT-0120C	400 lbs/ft2
FT-0160C	450 lbs/ft2
FT-0240C	450 lbs/ft2
FT-0320C	450 lbs/ft2
FT-0400C	450 lbs/ft2
FT-0600C	550 lbs/ft2
FT-0800C	500 lbs/ft2
FT-1000C	500 lbs/ft2
FT-1200C	400 lbs/ft2
FT-1400C	450 lbs/ft2
FT-0400S	675 lbs/ft2
FT-0600S	675 lbs/ft2
FT-0800S	525 lbs/ft2

5. Minimum Make-Up Air Required and Recommended Area of Opening for Vents

Model	Minimum Make-Up Air (SCFM)	Opening Area (in^2) Lower Vent	Opening Area (in^2) Upper Vent
FT-0080C	200	400	135
FT-0120C	300	600	205
FT-0160C	400	800	270
FT-0240C	600	1200	400
FT-0320C	800	1600	535
FT-0400C	1000	2000	670
FT-0600C	1500	3000	1000
FT-0800C	2000	4000	1335
FT-1000C	2500	5000	1670
FT-1200C	3000	6000	2000
FT-1400C	3500	7000	2335
FT-0400S	1000	2000	670
FT-0600S	1500	3000	1000
FT-0800S	2500	4000	1335

6. Access

a) Access around the heater should be provided to facilitate maintenance. Appropriate clearances for all sides follow.

b) Place heater with clearances to unprotected combustible materials, including plaster or combustible supports, not less than the following:

1. Heater Front 36” (1m)
2. Heater Sides 18” (.5m)
3. Heater Rear 18” (.5m)
4. Flue Pipe 18” (.5m)
5. Heater Top 60” (1.52m)*
6. *For burner removal. Burners may weigh up to 550 lbs. depending on the type and configuration. Customer to provide adequate means of burner removal.

c) All heaters will also require a minimum clearance of 5’ overhead for personnel access and burner removal. In cases where the available height is insufficient, a roof or ceiling trap might be considered.

d) Pipes should not be run within ten inches of any control cabinets or combustible material.

e) For UL listed units, see the specification plate on the Fulton Thermal Fluid Heater for these clearances. Verify that these clearances are acceptable with the local ordinances. Fulton Vertical Coil design units need only sufficient headroom for burner maintenance. However, in the event of major overhaul involving coil removal clearance as detailed in the **Minimum Clearance for Coil Removal** chart will be necessary. If this space is not available, the Fulton coil design unit may be removed to another area for coil removal.

f) Provision must be made for suitable access to the top of the heater. Larger models of the vertical coil design unit (FT-0320C and above) require an access ladder/gantry to be provided by the customer to allow clear access to the top of the heater for maintenance purposes. Fulton Thermal Corporation will advise on the suitability of the access provided and will be glad to give any assistance that may be required in this respect. Access provision should avoid possible contact with hot pipework, flues etc.

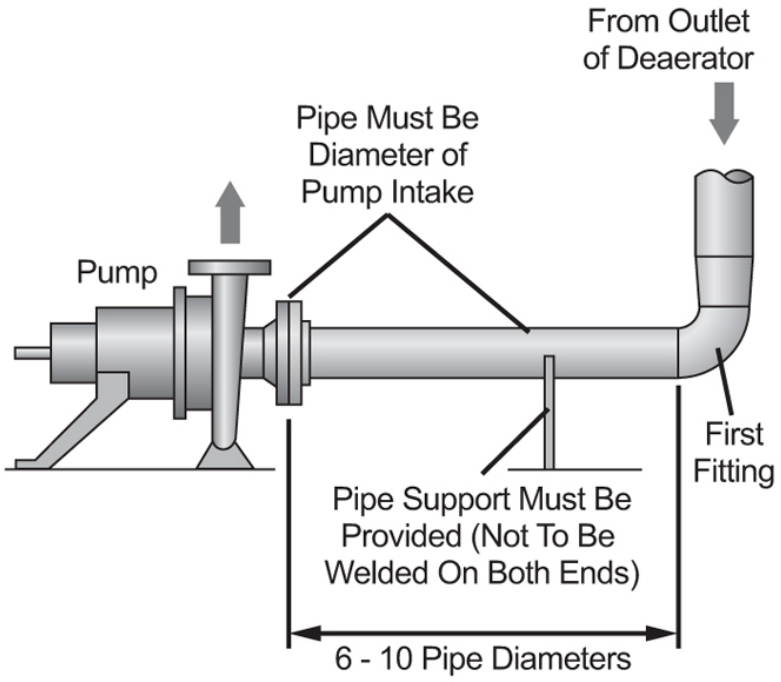
g) Failure to provide suitable and safe access at the time of commissioning may cause delays, as our Service Engineers are instructed not to commence commissioning if hazardous conditions exist.

Minimum Clearance for Coil Removal

Model	Inches	Meters
FT-0080C	60	1.6
FT-0120C	66	1.7
FT-0160C	66	1.7
FT-0240C	73	1.9
FT-0320C	80	2.0
FT-0400C	94	2.4
FT-0600C	124	3.2
FT-0800C	126	3.2
FT-1000C	126	3.2
FT-1200C	126	3.2
FT-1400C	140	3.6
FT-0400S	124	3.2
FT-0600S	124	3.2
FT-0800S	126	3.2

7. Circulating Pump

a) Installing the pump in accordance with the manufacturer's specifications and these instructions will prolong the life of the pump and contribute significantly to the successful operation of your Fulton heater system. The pump manufacturer's installation and operation instructions can be found in Section 5 of this manual.



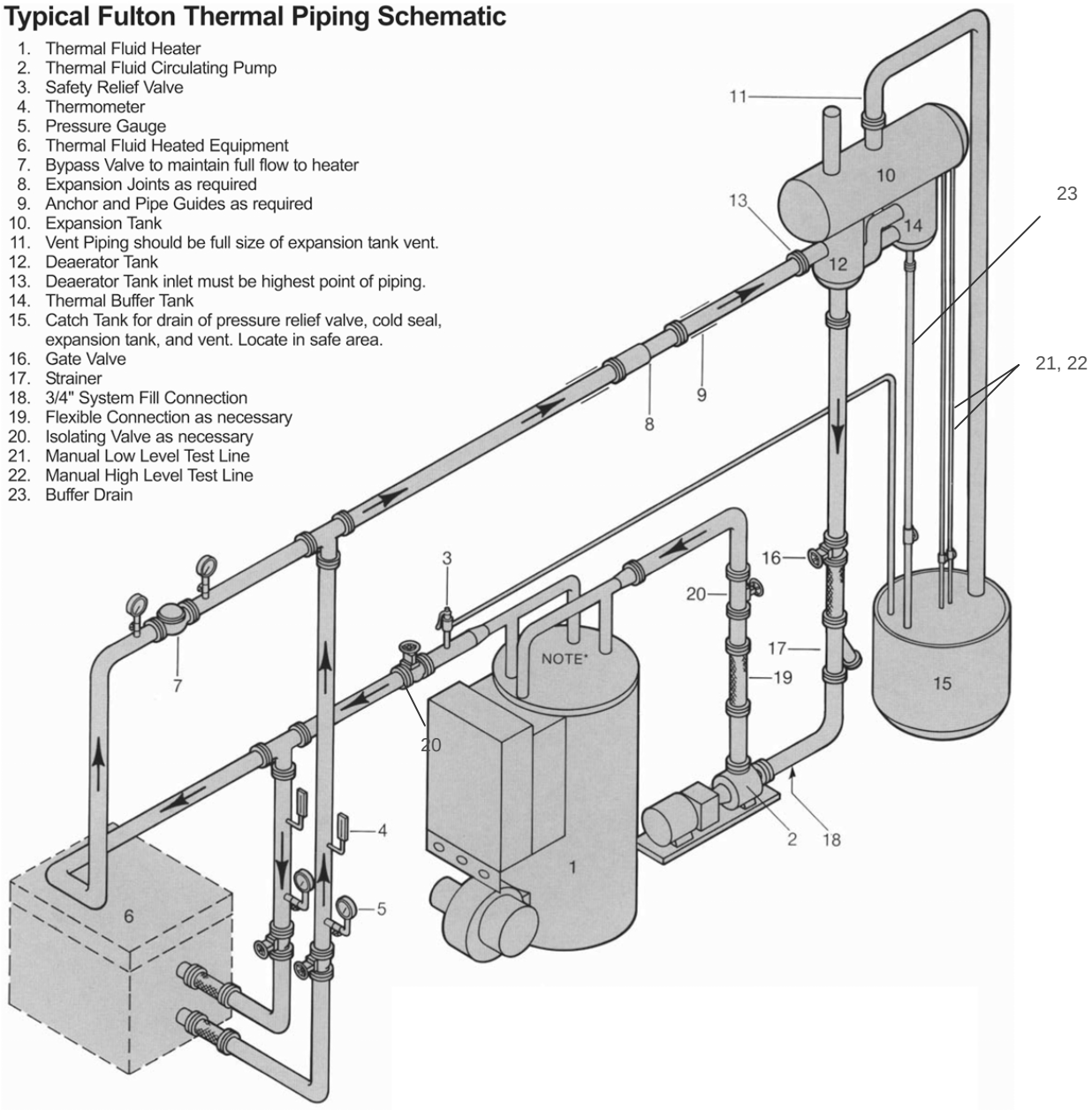
b) Location

1. The pump should be located adjacent to the heater. Its base must be firm, level (preferably concrete), and free from vibration.

c) Connections & Piping

1. The pump should be routed as per the manufacturer's requirements. It should be equipped with flexible connections at the suction and discharge sides. The primary function of these connections are to prevent stresses due to pipe expansion from being placed on the pump and to isolate pump vibrations from the pipe work and the heater. They also allow for expansion and deflection of the pipe work. These connections should be rated for high temperature since they are considered part of the piping system.
2. The suction pipe work must be directly connected to the deaerator section via a vertical run with as few elbows as possible, and should contain the strainer and an isolating valve. The discharge pipe work must be connected directly to the heater inlet, and should contain an isolating valve. See that pipe work connections match up accurately with pump flanges. Refer to the pump manufacturer's recommendations for the specific pump inlet piping requirements. Typically these requirements are that:
    a. It be a straight run of pipe.
    b. The straight run from the pump inlet to the first fitting, valve, or flex connector be a minimum of 6-10 pipe diameters in length.
    c. The pipe used should be the same size as the inlet of the pump.
3. The piping in the immediate vicinity of the pump must not be supported by the pump. The pump is not designed to bear the weight of the piping, and weight on any part of the pump will throw it out of alignment.

d) Typical Fulton Thermal Piping Schematic


Typical Fulton Thermal Piping Schematic
1. Thermal Fluid Heater
2. Thermal Fluid Circulating Pump
3. Safety Relief Valve
4. Thermometer
5. Pressure Gauge
6. Thermal Fluid Heated Equipment
7. Bypass Valve to maintain full flow to heater
8. Expansion Joints as required
9. Anchor and Pipe Guides as required
10. Expansion Tank
11. Vent Piping should be full size of expansion tank vent.
12. Deaerator Tank
13. Deaerator Tank inlet must be highest point of piping.
14. Thermal Buffer Tank
15. Catch Tank for drain of pressure relief valve, cold seal, expansion tank, and vent. Locate in safe area.
16. Gate Valve
17. Strainer
18. 3/4" System Fill Connection
19. Flexible Connection as necessary
20. Isolating Valve as necessary
21. Manual Low Level Test Line
22. Manual High Level Test Line
23. Buffer Drain
NOTE*

Note

The catch tank should be appropriately sized based on the system volume and configuration.

Under normal operating conditions, the catch tank should be empty.

Fluid that is expelled into the tank should not be reintroduced into the system.

e) Alignment

1. Proper alignment directly affects bearing, coupling, and seal life expectancy. The pump is properly aligned before it leaves the factory. Because the system expands in operation, pump must be realigned when the system is at operating temperature.
2. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.

f) Lubrication

1. An air cooled pump does not have an oiler. This type of pump has a sleeve bearing which is, like the seals, lubricated by thermal fluid. An air cooled pump has a grease nipple located at the drive end of the pump near the coupling connection. This comes pre-greased, and should be greased at intervals as recommended by the manufacturer.
2. An oiler is shipped with each water cooled pump and it should be filled with a lubricating oil recommended by the manufacturer. The suggested lubricant is usually SAE-30 non-detergent oil. Thermal fluid is not sufficient lubrication for bearings.

g) Seals

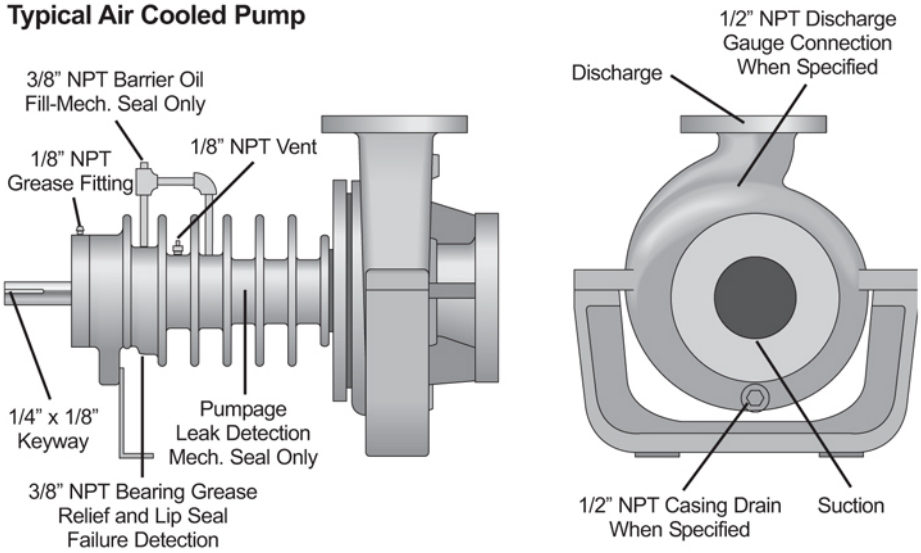
1. All seals on air cooled pumps are lubricated by thermal fluid, therefore the pump must never be run dry, i.e., without thermal fluid in it.
2. Filling a pump equipped with either a Grafoil packed or mechanical seal with thermal fluid will ensure lubrication. However, in order to be certain that all seals on an air cooled pump are coated with thermal fluid, the pump must be bled.
3. Grafoil packings require a run-in procedure. Typically, pumps with these seals are shipped with four or five rings installed and several rings loose. These extra rings must be on hand for the initial run-in procedure. See manufacturer's instruction manual for this procedure.

h) Air Cooling

1. Allow for free air flow around the entire pump casing at all times.
2. Max. room temperature should be 100°F.

3. In no case should any part of the drive side of the pump be insulated.
4. Max. operating temperature for air cooled pumps varies by manufacturer. Consult instruction manual to verify.

Typical Air Cooled Pump

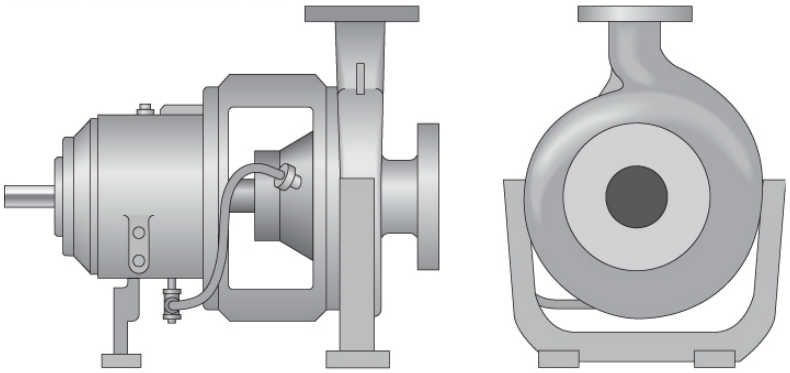

3/8" NPT Barrier Oil Fill-Mech. Seal Only
1/8" NPT Grease Fitting
1/8" NPT Vent
1/4" x 1/8" Keyway
Pumpage Leak Detection Mech. Seal Only
3/8" NPT Bearing Grease Relief and Lip Seal Failure Detection
1/2" NPT Discharge Gauge Connection When Specified
Discharge
1/2" NPT Casing Drain When Specified
Suction

i) Water Cooling

1. A throttling needle valve should be installed on the inlet side of the water cooling passages and adjusted so that the outlet water is between 120°F. and 160°F. Typically this means a flow rate of 2-5 GPM at 40°F inlet temperature. Consult pump manufacturer's specifications for dimensions of water cooling connection.
2. The throttling valve on a water cooled pump is designed to automatically give the proper flow rate for a 40 PSIG or greater supply.
3. If a minimum of 40 PSIG is not available, consult Fulton Thermal Corporation about resizing the orifice. If the temperature of the cooling water is greater than 55°F to begin with, a correspondingly greater flow rate is required.
4. For automatic operation of water cooling, wire a solenoid valve on the inlet to open whenever the pump motor starter is energized.

5. The outlet flow from the pump must not be restricted in any manner. Therefore, valves are not to be installed on the outlet. Check local codes regarding disposal of hot water.

Typical Water Cooled Pump



8. Combination Expansion/Deaerator/Thermal Buffer Tank

a) Fulton Thermal's efficient design combines the operation of the expansion, deaerator, and thermal buffer tanks. Installation is considerably simplified by virtue of this arrangement.

b) Expansion Section

1. The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. The customer should confirm the expansion rate of the chosen fluid and system volume.

c) Deaerator Section

1. At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation. This section of the tank must be insulated.

d) Thermal Buffer Section

1. A system of interconnecting pipe work in the thermal buffer tank section prevents the movement of any oil that has not cooled sufficiently into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the

atmosphere, which causes fluid breakdown. DO NOT insulate this section.

e) *Sizing The Tank For The System*

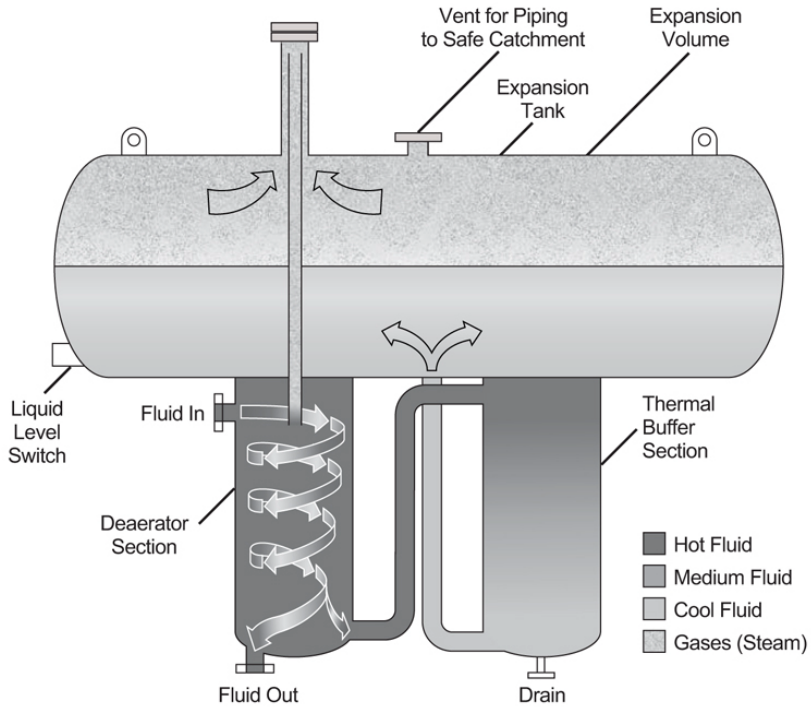
1. Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the top of the tank to avoid spillage or overflow. At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely and the expansion section must be filled to a level of 4 inches to "make" the liquid level switch.
2. The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

f) *Sizing Example*

1. A system contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it is 25%). 200 gal. x 1.25 = 250 gallons. 250-200 = 50 gallon expansion. The FT-200-L has only 46 gallons available for expansion, so the correct selection is the FT-500-L.

g) Location

1. The tank must be installed in accordance with Fulton Thermal Corporation's specifications.
2. Unless the system is pressurized, the inlet to the deaerator section must be higher than or equal to the highest point in the system to prevent pockets of air from collecting in system piping.
3. The head required at the circulation pump suction inlet must also be taken into account to avoid the possibility of pump cavitation. In systems operating close to maximum fluid temperature, the tank must be elevated enough, possibly well above the highest point in the system to prevent pump cavitation by increasing the static head. An inert pressurizing blanket may be considered as an alternative. See **Pressurized Systems.**
4. Supports for tank mounting should be provided by the client/contractor. These should be suited for supporting the tank by the side rails. The eyelets fitted to the tank are for lifting only.



Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-200-L	52	25	46	184
FT-500-L	132	40	121	525
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

9. Pressurized Systems

a) Nitrogen pressurization may be used to advantage where the total system content is very large or in a system operating near or above the vapor pressure of the fluid employed or if the inlet of the DA tank is not the highest point in the piping system.

b) In conjunction with this system, an automatic venting device must be fitted to the system expansion tank. Consult Fulton Thermal Corporation for further details.

c) The location for the liquid level switch is a 2-1/2” NPT connection on the same end of the tank as the inlet. The liquid level switch is supplied and shipped with the unit, and must be installed by the customer and then wired to the control panel.

Note

If the tank is located outdoors nitrogen is required.

10. Connections

a) The vent connection must be made in a manner that will prevent penetration of water or foreign bodies into the tank. This connection must always terminate in a safe, well ventilated area and has to be free of obstruction, open to atmosphere, and arranged in such a manner that, in the event of discharge from the system, thermal fluid could drain into a catch tank without danger to personnel or property.

Note

Non-code tanks cannot be pressurized over 15 psig.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through this connection.

b) The vent run should be the same size as the tank outlet. It should run pitch down from the outlet of the tank to the catch tank.

c) If nitrogen is used on the system, the vent can be reduced and should be piped with a positive closing valve at the catch tank.

d) The connection between the tank outlet and the horizontal pump inlet run should be as close to a vertical drop as possible. It should not contain an excessive number of bends of length of pipe. These faults could encourage pump cavitation.

e) As noted, the inlet to the deaerator must be higher than or equal to the highest point in the system or a pressurized system must be used.

f) The liquid level switch, supplied and shipped with the unit, must be installed and wired to the control panel by the customer.

g) The high and low level test connections are 1/2" NPT, and are located on the end of the tank opposite the inlet. The low level is on the center line of the expansion tank, the high level is next to it, slightly off center. The high level rises up from the bottom of the tank and ends four inches below the top; the low level rises two inches from the bottom of the tank.

h) Both the high and low level connections should be piped to a safe catchment. Valves should be installed in these lines at the catch tank.

i) Installation of the valves should be accomplished in such a manner that any flow will be visible when the valves are open.

j) Flow from the high level test connection indicates a tank that is too full; no flow from the low level test connection indicates too little fluid.

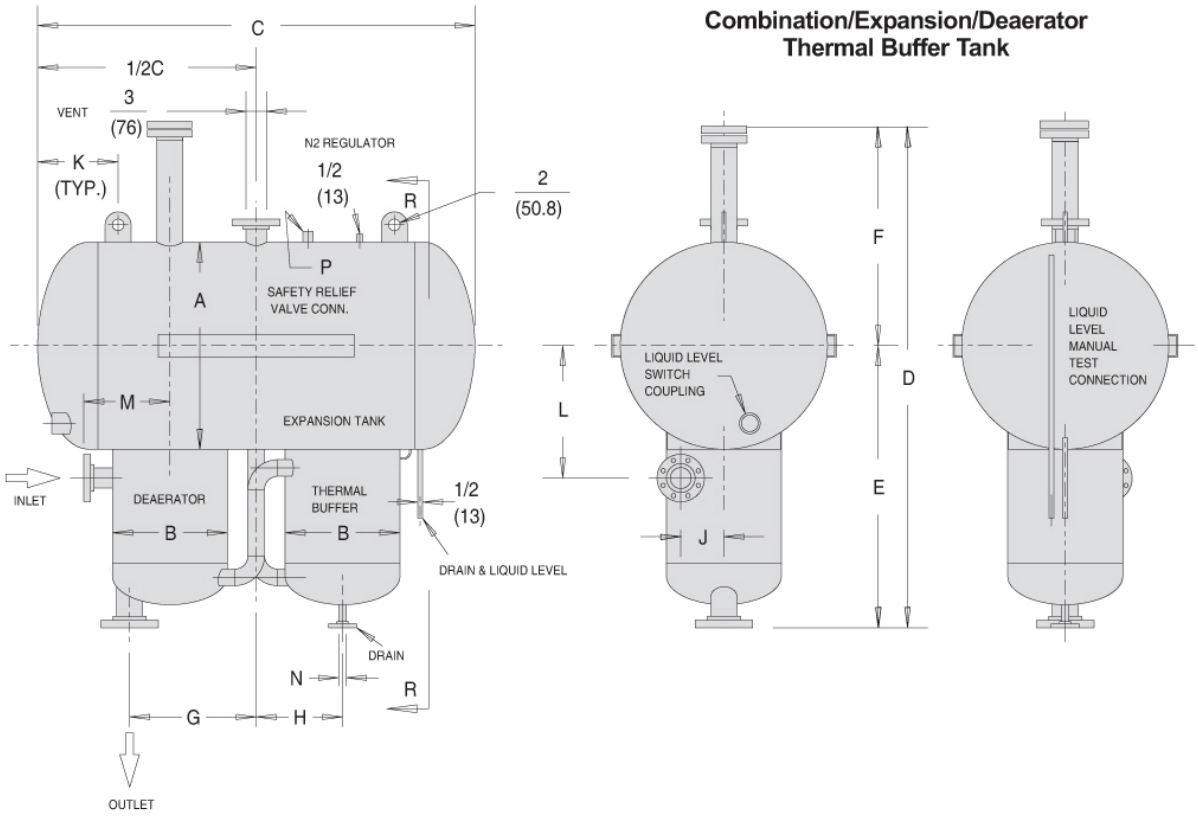
k) There is a 300 pound, raised face, flanged drain on the bottom of the thermal buffer section, for the purpose of draining the tank when necessary. This should be piped with a valve in the line, to a safe catchment. The valve specifications outlined above apply to this valve as well.

l) An inspection opening is located at the highest point on the tank. Access to this port is recommended but not required.

m) Refer to the maintenance schedule for recommendations on draining the buffer tank. For positioning of all connections on tank, see the diagram labeled Combination/Expansion/Deaerator Thermal Buffer Tank.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16 1/16 (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12 15/16 (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14 15/16 (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7 1/16 (202)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31 3/16 (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14 15/16 (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33 3/16 (843)	24 (610)	9 15/16 (252)	15½ (394)	28 (710)	18 15/16 (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅝ (1387)	32 3/16 (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18 15/16 (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)

n) Electrical Connections

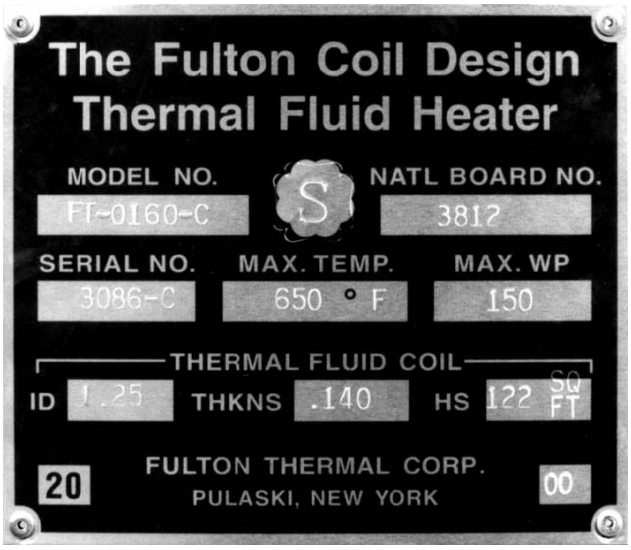
1. A wall-mounted, fused disconnect sized for the unit must be provided and fitted by the client/contractor, if a disconnect is not supplied on the panel.
2. Fuses must be sized according to motor name plates and local electrical codes.
3. Heaters and single skid systems are generally shipped completely prewired. The liquid level switch on the expansion tank, when supplied, will be shipped in the parts box and must be installed in the field. Multiple skid systems may require wiring between the skids.
4. If the unit is not skid-mounted at the factory, the client/contractor is required to wire the circulating pump starter.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

o) Voltage & Frequency

1. Normal supply will be 460 volts, 3 phase, 60 Hz, AC unless otherwise specified.
2. Make sure the information on the electrical drawing corresponds to your voltage and frequency. Check the supply voltage and make sure that there is no over-or under-voltage exceeding 10% of the nominal value.



p) Fuel Connections

Gas Connections

1. The burner assembly and gas controls terminate at a manual stop valve to which the gas supply should be connected. Piping should be sized for a gas flow consistent with the required BTU/Hr input. Large pressure drops must be avoided.
2. Fulton Thermal Corporation recommends that the supply piping between the pressure regulator and the inlet to the heater be kept to a minimum.
3. The minimum required gas pressure at the stop valve varies with the model of heater. The requirements for natural gas-fired coil design models are as follows:
    a. Models FT-0080-C to FT-0400-C and FT-0400-S: 14" w.c.
    b. Models FT-0600-C to FT-0800-C and FT-0600-S to FT-0800-S: 40" w.c.
    c. Models FT-1000-C to FT-1400-C: 120" w.c.

Note

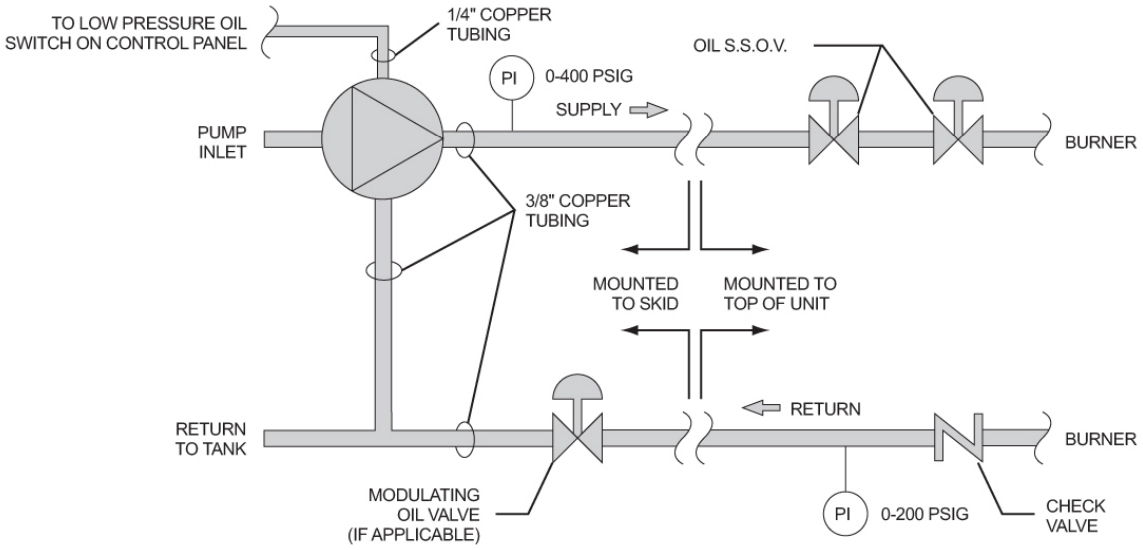
Low emissions burners for all models require 10 psi.

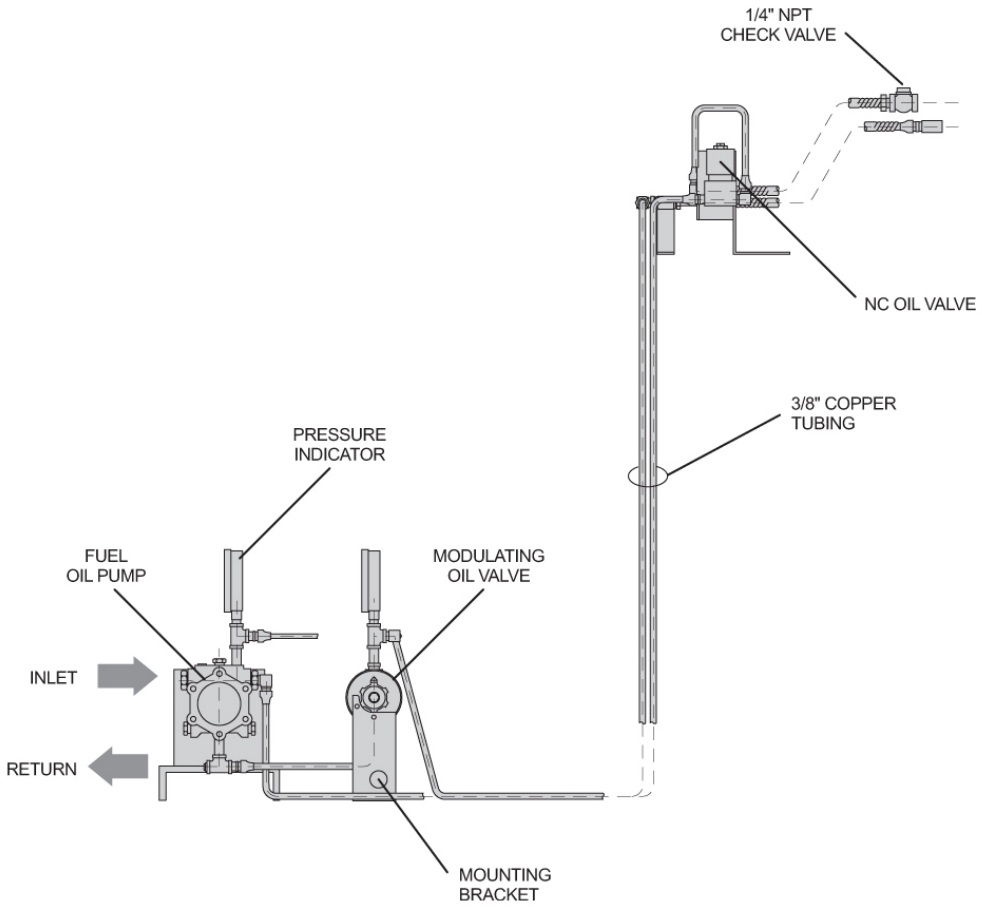
4. Even when the unit is shut down, the gas supply pressure must never exceed these values.
5. When operating, the supply pressure should not drop below these limits:
    a. Not less than 11 " w.c. where 14" w.c is required.
    b. Not less than 30" w.c. where 40" w.c. is required.
    c. Not less than 100" w.c. where 120" w.c. is required.
6. The supply pressure must be regulated by a non-stacking, tight, shut-off regulator.
7. Diaphragms, gas valves, pressure regulators, and pressure switches on all gas-fired units have vent connections which must be vented per local code.
8. On gas fired units with NFPA 85 valve trains, there is a vent valve which must be piped to atmosphere.

Oil Connections

9. Fuel pipes should be of approved materials and of a diameter suitable for the quantity of oil being delivered to the burner and the static head available. The fuel connection should be made in accordance with the details on the enclosed fuel pump cut sheet in Section 5. Fuel oil piping should be done in accordance with local/national requirements. In addition, if a two pipe system is employed, a check valve should be fitted into the return pipe. See fuel pump cut sheet.
10. The maximum pressure allowed at the fuel oil pump inlet is limited to 3 psig by the National Fire Protection Association (NFPA). If for some reason the pressure of the fuel supply will exceed this maximum, fitting a regulator to the fuel line must be considered, e.g. when there is a tank situated with an oil level eight feet or more above the pump.
11. On units fitted with NFPA 85 controls, ignition is obtained by means of a gas pilot. A natural gas or LP supply is required for these units. The required gas supply pressure is 7" w.c. If a guaranteed supply of natural gas is not available, then a supply of bottled gas at 11"w.c, is required. For details contact a local liquid propane dealer.

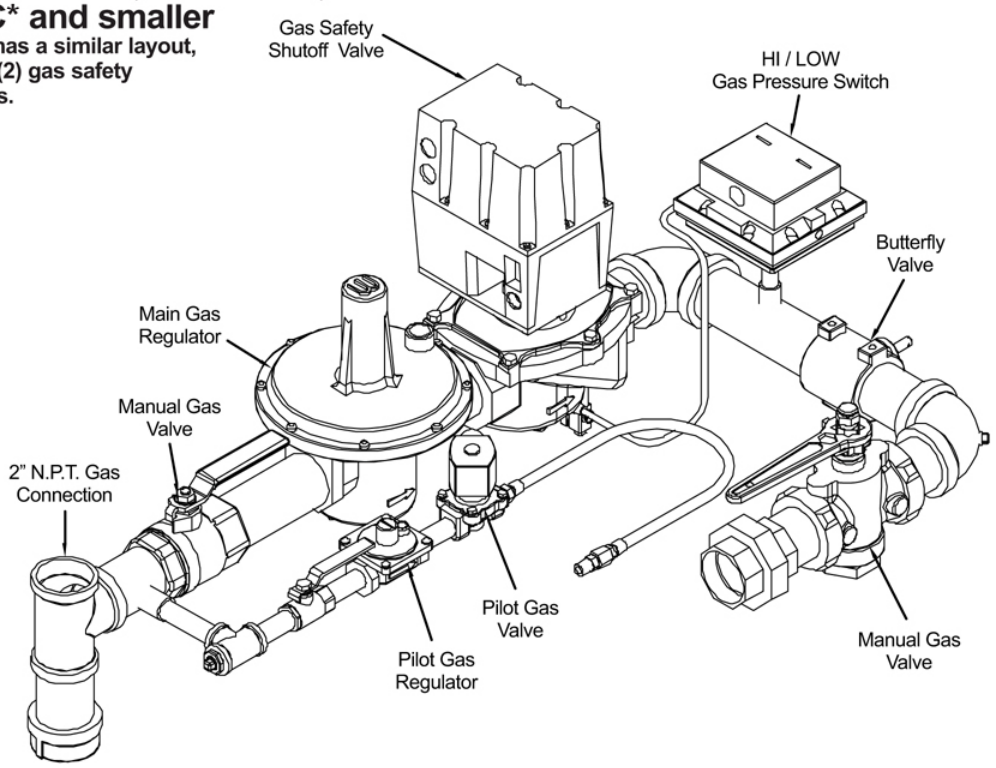
Typical No. 2 Oil Fired Fuel Train Illustration



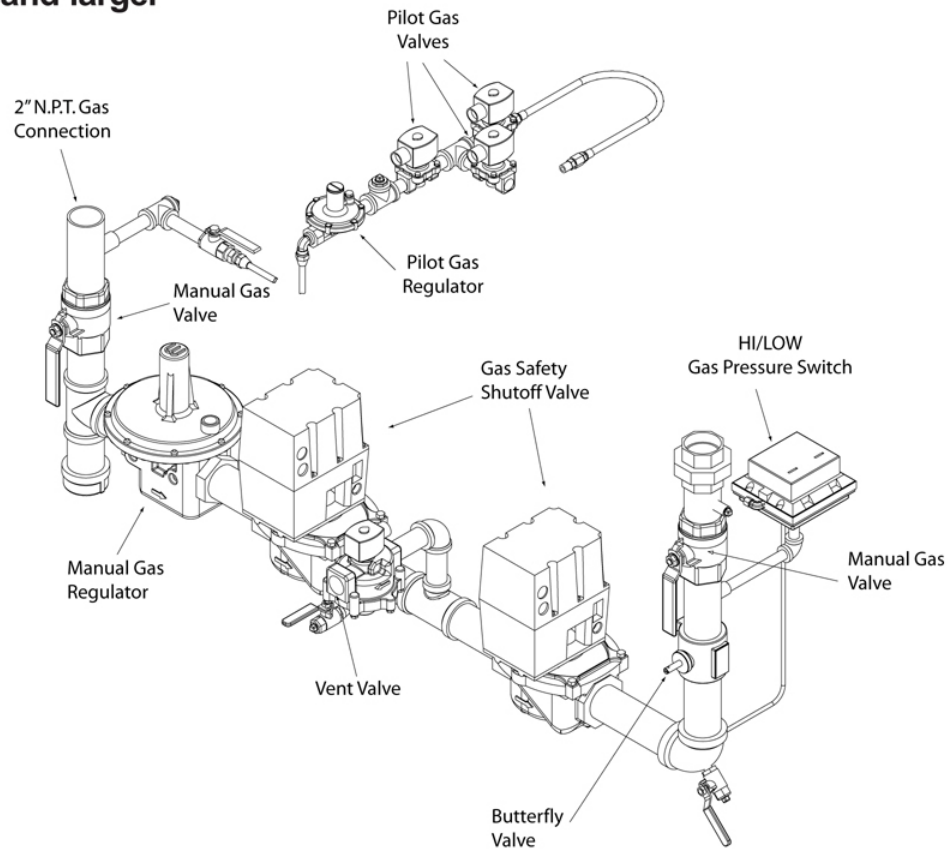


Typical Gas Fired, Modulated, CSD-1 Fuel Train Illustration FT-0320C* and smaller

The FT-400C has a similar layout, but uses two (2) gas safety shut off valves.



Typical Gas Fired Modulated, NFPA 85 Fuel Train Illustration FT-0600C and larger



q) Stack & Flue Connections

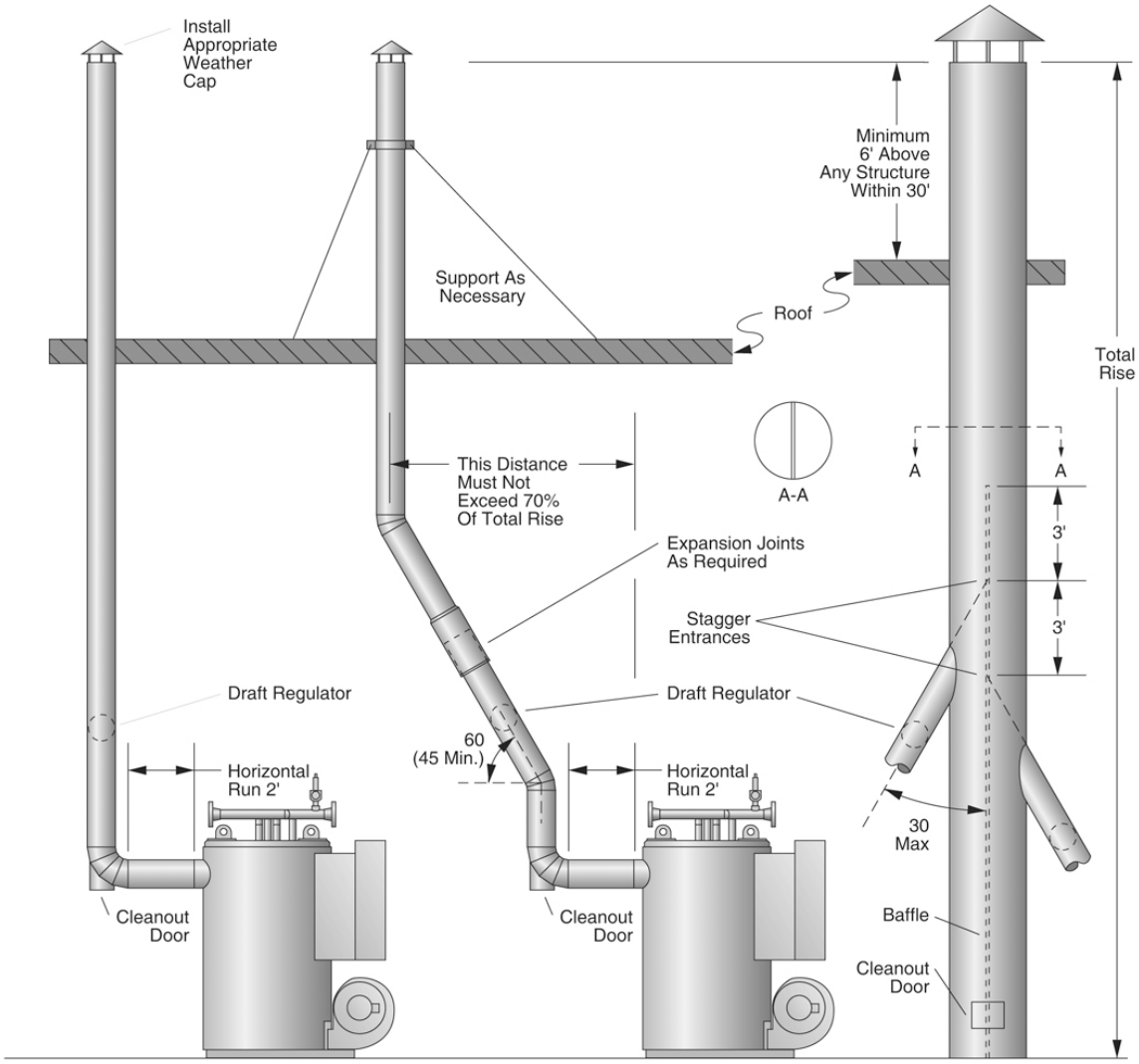
1. An appropriately sized stack should be connected to the flue gas outlet at the heater unit. The stack should be the same diameter as the flue gas outlet for an FT-0080-C, and at least one size larger for coil design models FT-0120-C and larger.
2. The stack should rise continuously to the connection of the chimney and should contain no more than two bends, at 45° angles or less.
3. There should be two feet of straight, horizontal flue before any change in direction, fitting, or draft regulator. This is to prevent potential pilot or main flame failures due to back pressure buildup during ignition.
4. Any alternative stack arrangement must supply negative .02 to 04" water column.
5. The run in the total distance of stack ducting, as measured in a straight line from the outlet of the heater to the outlet of the stack, should not exceed 70% of the rise. See diagram below.

Note

With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed four feet total.

6. The stack, chimney, and any components associated with the stack, such as heat reclaimers or assist fans, must be constructed from material that is rated for a 1200°F operating temperature.
7. Adequate provision must be made for the support of the weight of the chimney and stack to avoid having a load imparted to the outlet connection of the heater.

Typical Stack Arrangements



11. Conditions

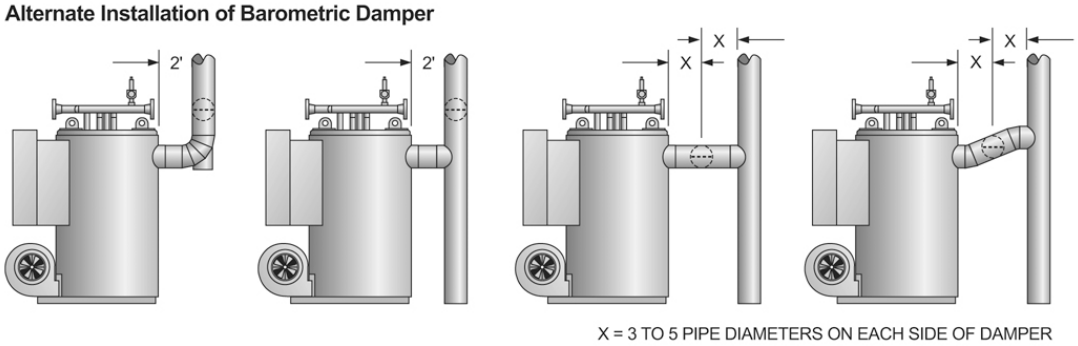
a) The draft when firing should be negative and constant. A reading of .02 to .04 inches w.c. negative when the unit and stack are cold usually indicates sufficient draft. When the unit is running and the stack is hot, the draft should read 0.04 - 0.08 inches w.c. negative.

b) The installation of a draft regulator by the client/contractor is recommended at all installations. This will help to maintain the required draft. The placement of the draft regulator should be as shown in the diagram labeled “Alternate Installation of Barometric Damper.”

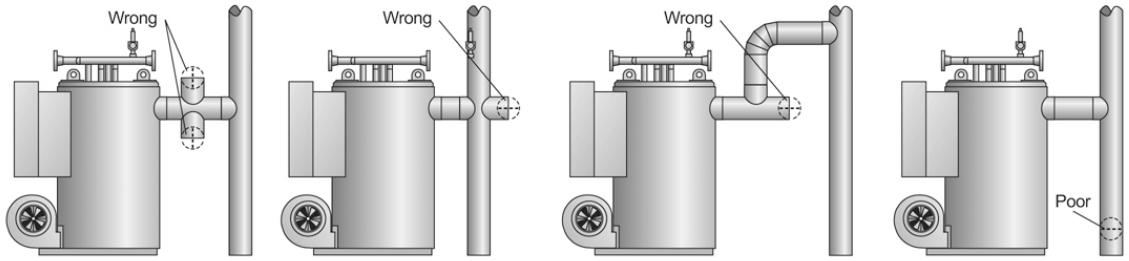
c) To maintain a reasonable temperature in the heater area and ensure safety to personnel, the section of chimney duct within the building should be insulated.

Installation of Barometric Damper

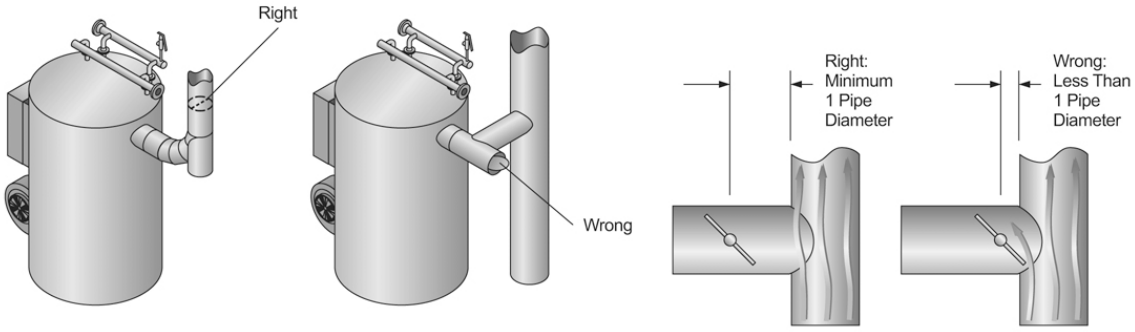
Alternate Installation of Barometric Damper



Wrong or Improper Installations of Barometric Damper



Proper and Improper Teeing of Damper



12. Pipework Systems

a) Certain properties of thermal fluid, including low surface tension, make it necessary to pay particular attention to containing the fluid. Good pipework system design, welded construction, proper flanging, gaskets, and other appropriate means of eliminating potential leakage must be employed.

13. General

a) All components exposed to thermal fluid flow, including pipe, valves, and screens, must not be made out of copper, copper alloys, aluminum, or cast iron. Cast iron is porous to thermal fluids, and copper and aluminum act as catalysts in the degradation of some thermal fluids. Carbon or stainless steel, or ductile iron, are recommended.

b) For standard applications, all components must be rated to 650°F unless otherwise stipulated.

c) All pipework, valves, and user equipment must be suited to the maximum operating pressure of the heater. The maximum pressure stamped on the heater nameplate is typically 150 psig (690 kPa).

d) If an isolating valve is completely closed, the pressure in the system will rise to the deadhead pressure of the pump. Suitably sized pipe will enable the system to withstand the total head generated by the circulating pump, should this occur. In applications where it is desirable to design to pressures lower than 100 psig, an alternative safeguard is to install appropriately sized safety valves.

e) Where secondary circulating pumps are installed, the system must be suitable for the aggregate head, against a closed valve, of both pumps.

f) During construction of the installation, ensure that no dirt, water, or residue from welding is left in the system.

14. Equipment

a) Heaters that are skid mounted with pumps and tanks are equipped with a y-strainer, a flex connector and a valve in the inlet run between the pump and the combination tank. Piping between the discharge of the pump and the inlet of the heater will include a flex connector and a valve.

15. Piping

a) All pipework should be constructed from seamless mild steel pipe, conforming to ASME SA 106B or SA 53B, Schedule 40 or equal.

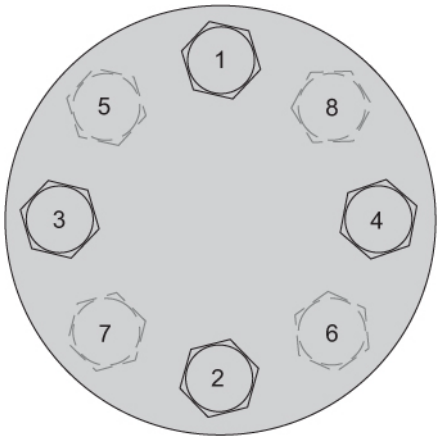
b) Expansion joints or properly designed and sited loops should be provided to accommodate thermal expansion. Thermal expansion should be calculated using the maximum possible utilization fluid temperature, regardless of whether the pipe considered is in the feed or return circuit. Steel pipe will expand approximately 1 “ per 100’ over a 100° F. temperature rise (1 mm. per meter over 100°C. rise).

c) Supports and anchors must be provided for all pipes where necessary to prevent undue stresses from being placed on items of equipment, including pumps, valves, and the heater. Supports and anchors which will not interfere with thermal expansion should be chosen.
d) All pipe joints should be of either welded or flanged construction. Screwed joints must be avoided where possible. In no instance should screwed joints be used in the flow circuit.
e) All flanges should be welded to the pipe and not screwed. Flanges should be 150# or 300# raised face flanges, SA105.
f) Gasketing material suitable for use with thermal fluids at high temperatures should be used to make all flanged joints. Flexible graphite gaskets are suited for most thermal fluids. Recommended gasket thickness is 1/10 - 1/8 inch.
g) Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer.

16. Gasket Installation Instructions

a) Lubricate nuts, bolts and washers with a graphite/oil mixture.
b) Assure that the flange surfaces are clean and free from damage.
c) Center gasket properly over flange. In retrofit, use pry bar to spread flange apart enough that the gasket will not be damaged when sliding in place.
d) Install all flange nuts and bolts.
e) Hand tighten.
f) Utilizing a torque wrench, tighten all bolts to 20% final torque specification following a “star” pattern. (This means do not tighten bolts in order as a clock. This will result in a poor seat between 12 o’clock and 1 o’clock.)
g) Tighten all bolts to 40% final torque specification following a “star” pattern.
h) Tighten all bolts to 60% final torque specification following a “star” pattern.
i) Tighten all bolts to 80% final torque specification following a “star” pattern.
j) Tighten all bolts to 100% final torque specification following a “star” pattern.
k) Following a sequential pattern, ensure that all bolts are tightened to 100% final torque specification.
l) It is important that all bolts are checked and re-torqued after flanges have been heated and cooled down for the first time.

Bolting Sequence for 4 and 8 Bolt Flanges



Standard gaskets supplied by Fulton are JM Clipper Elastograph for operating temperatures up to 650^{o}F.

Recommended Loads for JM Clipper elastograph 150# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	1/2	30
1	4	1/2	30
1 ¼	4	1/2	30
1 ½	4	1/2	30
2	4	5/8	60
2 ½	4	5/8	60
3	4	5/8	60
4	8	5/8	60
5	8	3/4	100
6	8	3/4	100
8	8	3/4	100
10	12	7/8	160

Recommended Loads for JM Clipper elastograph 300# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	5/8	60
1	4	5/8	60
1 ¼	4	5/8	60
1 ½	4	3/4	100
2	8	5/8	60
2 ½	8	3/4	100
3	8	3/4	100
4	8	3/4	100
5	8	3/4	100
6	12	3/4	160
8	12	7/8	245
10	16	1	160

17. Piping

a) High point bleeds are to be installed at all high points in the system piping. 1/2” x 12” nipples welded in the top of the piping with ball valves & plugs attached are to be used.

b) It will save a considerable amount of time during the cold filtration if the thermal system piping is cleaned prior to assembly.

c) The mill scale (the results of oxidation) on the inside of the piping as well as construction debris can foul the oil and cause the need for the filters to be

cleaned more than need be. This can range from simply using a rag to ordering pickled pipe. (“Pickling” is a process where the piping is first soaked in an acid bath, then soaked in a neutralizing bath, then given a protective oil coating.)

d) All pipes should be installed with a pitch to facilitate draining and venting.

Standard gaskets supplied by Fulton for operating temperatures above 650°F are Flexitallic Spiral Wound.

Recommended Loads for Flexitallic Spiral Wound Class 150# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	1/2	45
1	4	1/2	45
1 ¼	4	1/2	45
1 ½	4	1/2	45
2	4	5/8	90
2 ½	4	5/8	90
3	4	5/8	90
3 ½	8	5/8	90
4	8	5/8	90
5	8	3/4	150
6	8	3/4	150
8	8	3/4	150
10	12	7/8	240

Recommended Loads for Flexitallic Spiral Wound Class 300# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	5/8	90
1	4	5/8	90
1 ¼	4	5/8	90
1 ½	4	3/4	150
2	8	5/8	90
2 ½	8	3/4	150
3	8	3/4	150
3 ½	8	3/4	150
4	8	3/4	150
5	8	3/4	150
6	12	3/4	150
8	12	7/8	240
10	16	1	368

18. System Connections

a) If screwed connections have to be made, e.g. to items of control equipment, then a thread sealant suitable for use with fluids at elevated temperature must be used. Teflon tape, standard pipe dope, or hemp and paste are not acceptable.

b) Screw threads must be carefully and accurately cut. If possible, new tools should be used. Threaded connections larger than 1" are not to be used. It is recommended that GR5 or better tensile steel bolts be used for all flanged joints.

Note

The system pump is not to be used to fill the system.

c) The system is usually filled from the lowest point, with the aid of a pump. On skid-mounted units, a drain and fill connection is provided in the inlet piping to the pump.

Drain and Fill Connection

19. Heater Connections

a) The outlet of the pump should connect directly to the inlet of the heater via an isolating valve and pump flexible connector.

b) The heater outlet should be piped directly to the system, via an isolating valve.

c) A safety relief valve may be shipped in the parts box accompanying the fuel-fired heater, and must be installed in the outlet manifold. On all units, the outlet must be piped to a safe discharge area. The piping from the outlet of the safety valve must be piped to a catch tank. The discharge flow must not be restricted, i.e. no valve should be installed. The weight of the piping must be properly supported in order to prevent damage to the safety valve. If the valve body becomes warped, leakage may result.

20. Gauges

a) The range in which readings are expected to fall should comprise mid-scale on the pressure gauge chosen. Pressure gauges must be able to withstand overpressure equal to the rating of the safety relief valves, normally 100 psig.

b) Thermometers should read up to 650°F.

21. Valves

a) Vent and drain valves should normally be 1/2” or 3/4” with internal seals made from materials suited to use with thermal fluids. They may be of the screw type if installed on stalks not less than 12” long.

b) Gasketing material specifically suited to the task must be used.

c) Drain valves should be fitted at all low points in the pipework system and ventilating valves should be fitted at all high points in the installation.

d) Valves must be fitted with either the conventional packed stuffing box seal or a bellows seal as required. Where the stuffing box is specified, it should be as

deep as possible and packed with Grafoil packing or equal. The valves should have a backseating to allow re-packing without draining the system. In all units, a “Y” type strainer should be installed in the fluid return line, between the deaerator tank and the circulating pump.

e) As previously stated, this strainer is provided on all skid-mounted units. Valves must be provided (unless the heater has been skid-mounted with the tank) so that the strainer can be isolated for cleaning of the element. The strainer element should be 60 mesh and must remain in place during normal operation of the system.

f) The pump suction pressure should be checked periodically, under similar operating conditions. A vacuum reading on the suction gauge indicates that the screen must be cleaned. For isolating purposes, globe, wedge, gate, ball, or other shut-off valves should be used. When there is a likelihood that some manual balancing will be required, a ball or globe valve should be used.

g) Manual control and isolating valves should be the flanged or weld type, manufactured from cast or forged steel or ductile iron, with internals and gland seals made from materials suitable for use with high temperature fluids.

h) When ordering valves, the maximum possible service temperature and type of fluid must be indicated on the order.

i) A partial list of manufacturers known to market valves of acceptable quality follows:

    1. Jenkins Brothers
    2. Lunkenheimer Company
    3. Nibco Incorporated
    4. Stockham Valves and Fittings Company
    5. Velan
    6. Vogt Machine Company
    7. Worcester Valve Company

j) Automatic Fluid Control Valves

    1. Because of the widely varied processes Fulton Thermal Fluid Heaters are used in, it is not possible to set down specific rules for the selection of automatic fluid control valves. Generally, these valves must satisfy the materials and construction requirements described above.
    2. The type of operation and design of porting are governed by the degree of control required as well as the particular application.

k) Bypass Valves

1. When process flow requirements do not match heater flow requirements, a by-pass valve must be installed.
2. If the process flow will vary with the system load, a suitable bypass system can be recommended by Fulton Thermal Corporation.

22. Testing

a) Upon completion of the installation, a pneumatic test not exceeding 15 psig should be conducted. Soap tests should be made at all welds and joints to ensure that the system is free from leaks.

b) Under no circumstances should the system be filled with water. Make sure that the air supply is as free from moisture as possible.

c) The most satisfactory method of testing is to introduce bottled nitrogen through a pressure control valve. Check pressure ratings on all the equipment in the system to make sure that it is capable of withstanding the pressure involved.

d) The time needed to be spent during boilout directly corresponds to the amount of moisture in the system. Boilout can take anywhere from two to three days to complete. Pressure testing on the system should be done by means of an inert gas, such as nitrogen, or by an air compressor producing dry air (air with a dewpoint of 50^{o} F or less). Never perform a hydrostatic test on the system.

23. Insulation

a) After the appropriate system tests have been satisfactorily completed, all hot pipework, including manifolds on the heater, must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

Caution

For reasons of safety, the hot exhaust gas duct and chimney must be insulated or shielded within the locality of the heater.

b) The deaerator section of the combination tank must be insulated. The expansion section of the combination tank must not be insulated, nor should the thermal buffer section.

c) On units operated with inert gas blankets above the fluid in the expansion tank, the entire combination tank, including the expansion and thermal buffer sections, may be insulated, but is not necessary.

d) It is recommended that for inspection and maintenance, pumps, flanges, valves, and fittings be left un-insulated but suitably shielded for safety.

e) Hot oil pipe insulation should be a minimum of 2” thick, high temperature, laminated, foamglass cellular glass insulation as manufactured by Pittsburgh Corning Corporation, or equal.

24. Thermal Fluids

Thermal Fluids at Elevated Temperatures

a) Plant engineers must be familiar with the nature of potential hazards when working with thermal fluids at operating temperatures.

b) Unlike steam or high-pressure water systems, thermal fluid attains extremely high temperatures without a corresponding increase in pressure. While this lack of high pressure in the system yields many advantages, a false sense of security should not be allowed to develop on account of this alone.

c) Certain types of thermal fluid may have operating temperatures reaching 650°F (345°C) and above, so all exposed pipework is hazardous and should be insulated, as indicated in the preceding sections.

d) Flanged joints must be checked for tightness during and after the first warming up of the system. After these checks, exposed hot flanges, pumps, valves and fittings should be fitted with some sort of shield.

e) It is important to remember that there is pressure generated in the system by the circulating pump. Great care should be exercised when opening any drain or vent valves in the system.

f) This is especially important during commissioning, when any air trapped in the system is vented at high points, and when water, which will flash into steam, is either expelled from the deaerator vent or drained off at low points.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

g) If a fire does occur, extinguish using CO2, foam or dry chemical. DO NOT USE WATER.

h) Selecting a Thermal Fluid

1. The selection of the thermal fluid most suited to your application is very important. Factors to be considered include efficiency, thermal stability, adaptability to various systems, and physical

properties, including vapor pressure, freezing point, and flash and fire points.

2. Heat transfer fluids of both mineral and synthetic origin have been specially developed to give thermal stability over a very wide range of temperature. A wide variety of thermal fluids have been used successfully in Fulton Thermal Fluid Heater systems, however, your final selection should be made in conjunction with Fulton Thermal Corporation or the fluid manufacturer.
3. The Fulton coil design heater is a fired heat exchanger and the safe control and monitoring of the thermal fluid temperature is of paramount importance.
4. The safe maximum bulk temperature of the fluid must be strictly adhered to. The safe maximum temperature of the fluid varies, but a typical maximum for many types of mineral oil based fluids is 600°F (320°C).
5. Special care must be taken when consulting fluid manufacturers' literature, as maximum fluid temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a "film temperature" which is higher than the temperature of the "bulk" of the fluid.
6. It is the BULK fluid temperature and NOT the FILM temperature that is indicated by the instruments.
7. As a general guide, the following list of fluids that have given satisfactory service over many years is provided.
8. This is by no means a complete list. Any fluid specifically designed for heat transfer use may be considered; multipurpose oils are not acceptable.

a.	AMOCO	Transfer Oil 4199
b.	CHEVRON	Teknifax
c.	DOW	Dowtherm A or G
d.	EXXON	Caloria HT 43
e.	MOBIL	Mobiltherm 603 or 605
f.	MONSANTO	Therminol
g.	MULTITHERM	PG1, IG4, IG1
h.	PARATHERM	Paratherm NF or HE
i.	PETROCANADA	CalFlo, AF, Purity FG, CalFlo LT
j.	SHELL	Thermia 23
k.	TEXACO	Texatherm

9. Any fluid specifically designed for heat transfer use must also exhibit these characteristics:
    a. Be a stable and homogenous liquid to a temperature of at least 100°F over and above the maximum intended temperature of utilization, compatible with metals used in the installation, and tolerating contact with atmospheric air.
    b. The absence of any solid matter in suspension.
    c. Non-toxic in the case of leakage.
    d. Sufficient lubricity, i.e. not likely to cause seizure.
10. The thermal fluid manufacturer must guarantee the characteristics of the product, and verify that the fluid bulk temperature limitation exceeds the expected operating temperature.
11. After a fluid is selected, refer to the manufacturer's recommendations, published in compliance with OSHA.
12. If the fluid expansion volume from 50^{o} F to 600°F exceeds 20% of the initial fluid volume, consult Fulton Thermal Corporation.

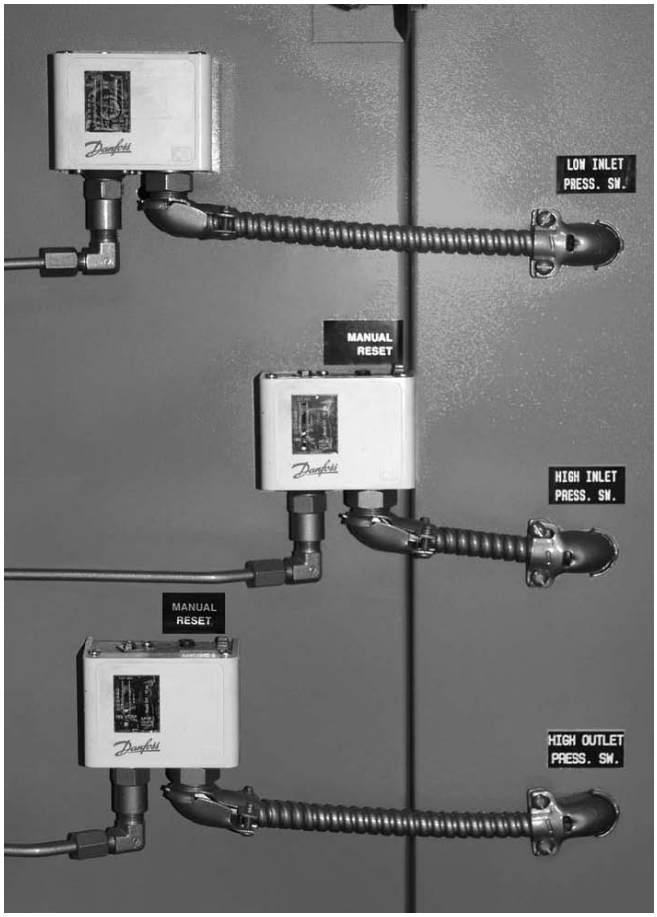
Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

i) Routine Analysis of Heat Transfer Fluid

1. Nearly all leading manufacturers of heat transfer fluids provide an after sales service to monitor the condition of the fluid in operation and make recommendations when replacement becomes necessary.
2. Each fluid manufacturer has procedures for regular testing and analysis of the fluid. These usually allow for a sample to be taken and analyzed at least once a year, although actual frequency will depend on operating temperature, number of hours operated weekly, and the results of tests made during the first weeks of system operation.
3. Fulton Thermal Corporation recommends that the thermal fluid in your system be analyzed within the first two months after start-up.

4. During the first few months of operation, sampling may be carried out at frequent intervals to confirm that system performance has been predicted correctly.
5. If the supplier of your thermal fluid does not contact you within four weeks of commissioning, contact the supplier and make certain that the “fill” is registered for routine analysis.

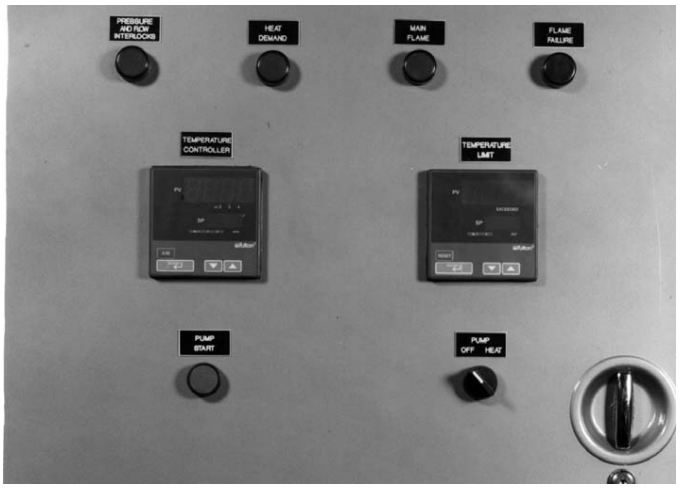


j) Thermal Fluid Breakdown

1. The possibilities of thermal fluid breakdown are very slim in a typical closed loop thermal fluid system. Fulton’s D/A tank creates a “cold seal” of fluid that is slightly above ambient temperature. This prevents oxidation that will happen when high temperature fluid contacts air.
2. This will also occur when hot thermal fluid contacts air at a leak in the system piping. Oxidized thermal fluid becomes acidic and will damage the thermal fluid system. Thermal fluid breakdown can occur in sections of piping where there is a low flow

condition. A low flow rate through the heater will result in high film temperatures leading to breakdown of the thermal fluid.

3. Multiple pressure switches and a differential pressure switch are used to prevent this condition from occurring. These safeties must not be bypassed at any time.
4. Exceeding the maximum operating temperature of the thermal fluid will also result in thermal fluid breakdown. Fulton heaters are equipped with a temperature limit switch (located on the front of the panel box) to prevent this from occurring.



5. A high temperature limit switch acts as an over temperature safety device. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed. The reset button on the flame programmer must also be pressed to reset the unit before it can be restarted.

Section 3

Section 3 – Operation

1. Start-Up Preparation & Installation Review

a) Check with local authorities where approval for start-up is required. In some localities, final inspection of services may be required.

b) Review the installation section of this manual carefully. Confirm accordance with installation guidelines, including:

1. In general, ensure that the heater area is in conformance with established heater room requirements. Review national and local codes.

2. Preparation

a) Check for total absence of water in pipework and fluid. To help the system, open all drains; blow air nitrogen if available into a high point bleed through a pressure regulating valve.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

b) Make sure that there are no obstructions left in the thermal fluid circuit from pressure leak testing such as blanking plates in flanged joints.

c) Check that pipework is free to expand naturally when hot. Open all valves to user circuits including air bleed valves at high points and drains at low points in the piping system, and the liquid level test connections in the expansion section of the combination tank.

3. Filling the System

a) The viscosity of thermal fluid is generally very high (500 cS) at ambient temperature. Below 50°F (10°C) some fluids become very thick. Fluid should be in a pumpable liquid form prior to filling the system.

b) Filling must be carried out from the lowest point in the system in order to prevent air pockets from forming.

c) A drain and fill point (generally a 3/4” threaded coupling) is provided on the inlet to the pump suction on skid-mounted units. Typically a portable, high velocity pump, such as the type used for chemical transfer, is appropriate for filling the system. Where only one or two drums of fluid are required, a handheld pump may be practical.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Drain and Fill Connection

d) Filling Procedure

1. Fill the system slowly, closing all opened bleed and drain valves as fluid reaches them.
2. When the fluid reaches and flows from the expansion tank low level manual test connection, begin slowing down the filling process.
3. Close the low level connection and continue to fill until the liquid level switch closes. After fluid appears in the low level connection, only a small amount of additional fluid should be required.

4. If fluid is observed coming from the expansion section high level manual test connection, drain fluid from the tank until the level is between the liquid level switch and the high level connection.
5. Filling is complete when the fluid has reached the lowest level in the expansion tank required to actuate the liquid level switch. Check to see that the liquid level switch operates freely. To confirm operation of the liquid level switch, manually trip the liquid level switch. Unit should shut down; pump will stop.

4. For Systems Equipped with Inert Blankets

a) Follow the instructions listed under “Filling The System”.
b) Pay close attention to notes and warnings.
c) Inspect the system to be sure all valves are open and all drains are closed.
d) Open all high point air vents.
e) Do not pressurize the system with nitrogen at this point.
f) Inspect the liquid level switch and be sure the switch is functioning properly.
g) Begin filling the system.
h) Fill the system until the liquid level switch indicates there is oil in the expansion tank.
i) Pressurize the system slightly with nitrogen. Leave the high point vent connections open, as the nitrogen should be isolated from the vents by the oil in the system. The pressure required in the system at this point is only 2-3 psi. If too much pressure is applied, the nitrogen will bubble through the oil and vent to atmosphere. If this happens, reduce the pressure.
j) Continue filling the system. If liquid level switch is made, be sure to observe the high point vents as oil is now entering the elevated portion of the pipe work. As oil reaches the vent, close it. After all vents have been closed, and you believe the system to be full, stop filling. Start the circulating pump as described under “Cold Circulation.” Leave the fill equipment connected as cleaning the strainer may create the need for more oil in the system.
k) The final nitrogen pressure is determined by measuring the difference between the D.A. Tank inlet and the highest point in the system. Divide that number by 2.31 (this will indicate the nitrogen pressure the system should be set for). Adjustment can be made via the regulator mounted on top of the D.A. tank.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

5. Circulating Pump

a) Read manufacturer's instruction manual thoroughly. If the pump is supplied by Fulton Thermal Corporation, manufacturer's literature is included in this manual.

Note

Do not run the pump before filling it with fluid.

b) The pump should never be run without fluid in the casing. For pumps equipped with mechanical or air-cooled seals, air must be bled out of the stuffing box area to ensure that thermal fluid has lubricated all seal and bearing areas. Operation of the pump even a short time without bleeding first will damage the pump.

c) Also use the thermal fluid as a barrier fluid. Remove the 3/8" plug at the barrier fluid fill port. Fill the cavity with thermal fluid until it comes out of the overflow tube. Replace the 3/8" plug.

d) Mechanical/Air Cooled Seal

1. Open the air bleed connection located directly over the pump shaft. Replace plug when a steady stream of thermal fluid, free of entrained air, flows from the port.
2. If flow has not started after two to five minutes, remove the coupling guard and rotate the pump shaft by hand in the proper direction. This should help move the cold viscous fluid through close tolerance seal areas. Replace plug when flow is steady.
3. If this fails to induce flow, introduce fluid through the bleed port and rotate the shaft by hand to work the fluid around the seal area. Continue to add fluid and rotate the shaft until no more fluid can be added.
4. Replace the plug and run pump for five to ten seconds. Stop the pump, remove the plug and wait for flow to start. If after two minutes flow has not started, add more fluid as described above and run the pump for five minutes.
5. Constantly check the bearing area (located immediately behind the casing) for overheating. Remove the plug and check for flow.
6. If flow has not started at this point, the fluid may be too viscous to move through the seal area. Start the system normally by selecting heat on the control panel, and raise the temperature 50°F. Continue to raise the system temperature by 50°F increments. Keep checking the pump until flow starts.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

7. The pump should not be subjected to thermal or pressure shock. The thermal fluid should, therefore, be allowed to flow into the casing slowly.
8. Check field work and make sure that all connections have been made in the proper places. Check electrical connections to the motor.
9. Rotate the pump shaft by hand to be sure there is no binding or rubbing within the pump or driver. Correct any problems immediately.
10. Check to see that pump is properly aligned while cold.
11. The pump is properly aligned before it leaves the factory. Because the system expands in operation, the pump must be realigned when the system is at operating temperature.
12. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.
13. Realign at operating temperature, if necessary.
14. Make sure that the pump is properly greased or oiled.

e) Pumps with Packed Seals

1. Make sure that the gland is finger tight before filling the system.

6. Initial Start-Up

a) These instructions are for use when the unit is being started up for the first time, or after prolonged shutdown. They are to be used in conjunction with the specific procedure information in titled section, “Routine Operation.”

7. Start-Up Service

a) If start-up service has been included in the order, the factory should be contacted after the installation has been successfully completed and approved by the client's representative or engineers. Where possible, contact the factory at least one week before a Fulton service engineer is required on site.

b) All procedures covered in Operating Instruction sections "Start-Up Preparation" and Filling the System," including installation review, air testing of piping, pump alignment, and filling the system must be completed before the service person's arrival.

c) Depending on the size of the system and the amount of service time contracted for, start-up service includes firing the heater, boiling out the system, checking, verifying and adjusting all safety settings.

d) Careful preparation can expedite the commissioning of your heater. Most delays can be avoided by following the instructions in this manual. Failure to complete required procedures properly can result in the need for further service time, at extra cost to the customer.

e) Service people will not commence start-up if there are obvious system deficiencies. However, start-up service in no way constitutes a system design check or approval of the installation.

f) In addition to commissioning the heater, the service person will also familiarize heater room personnel with the operation of all Fulton equipment. Personnel must be qualified to understand the basic operation and function of controls.

8. Cold Circulation

a) Turn on the main power switches.

b) Check for proper fluid level in the expansion section of tank.

c) A centrifugal pump cannot be operated with the discharge valve closed without heating up dangerously.

d) The pump should be started with the suction valve full open and the discharge valve open a slight amount.

e) Check pump rotation. Operating the pump in reverse rotation may cause extensive damage.

f) Turn the three position switch located on the front of the panel box door to "Pump".

g) Jog the green pump motor starting button and observe the direction of rotation. Rotation should be in the direction of the arrow shown on pump casing.

h) If the rotation direction is incorrect, turn the three position switch back to "Off" immediately. Change the wiring connections and recheck.

i) Check for proper alignment. Realign, at temperature.

j) With the control switch set to “Pump” push and hold the pump start button, check all manual resets on pressuretrols. The circulating pump will run, but the burner will not fire.

k) If the pump stops when the button is released, check for proper flow in the system, and review settings of high and low fluid pressure switches and differential pressure switch. Check liquid level switch.

l) Check that all pressure gauge readings remain stable. Pressure exceeding 100 PSIG or identical readings at inlet and outlet gauges indicate a closed valve.

m) If an extremely high vacuum (i.e.15” Hg or more) is indicated on the compound gauge, the valve between the circulating pump and the combination tank may have been left closed. In this case, little or no pressure will be indicated by other gauges.

9. Filtering the System

a) Initially, readings on the compound gauge will indicate zero or slightly positive pressure. During the first few moments of flow, this reading will go towards vacuum, indicating that the strainer is becoming plugged.

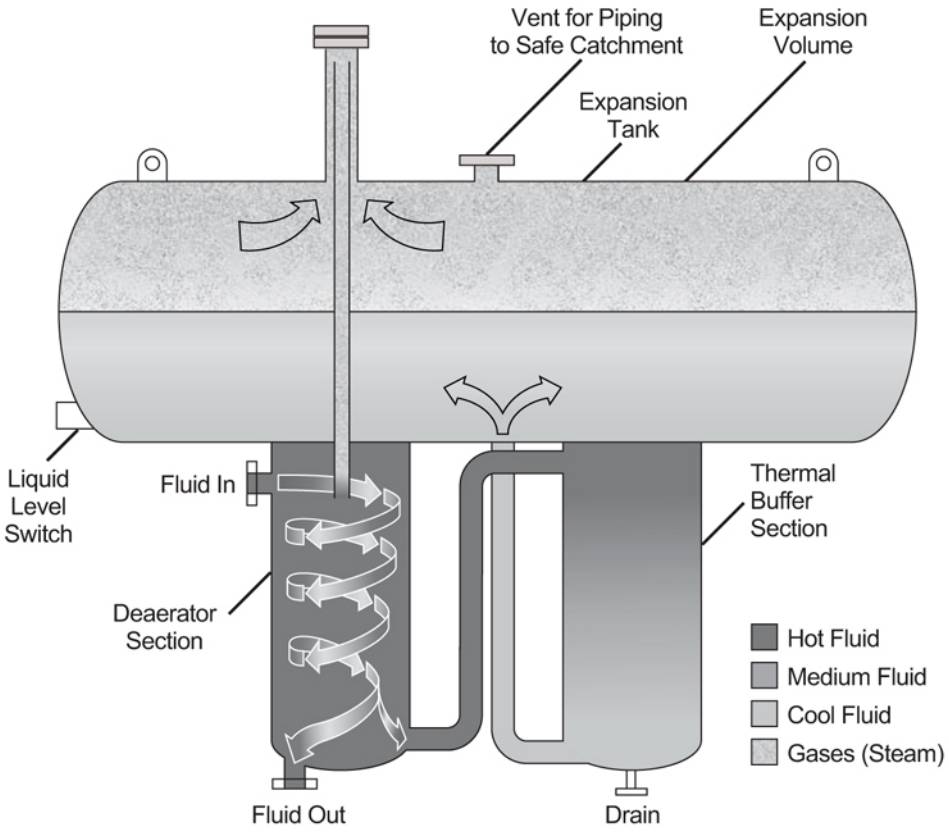
b) Typically, a reading of 3” Hg or greater vacuum on the pump suction gauge indicates that the strainer must be cleaned. The strainer screen should be back flushed or pulled, cleaned and replaced.

c) Strainers should be cleaned by means of compressed air. A rag will merely force the smaller particles into the mesh of the strainer. It is recommended to place a lint free rag in the center of the strainer and blow air from the outside, trapping the debris in the rag.

d) Allow the pump to run again for several minutes and repeat the filtering process until pump suction pressure remains steady after cleaning. The amount of time which must be allotted for filtering varies with the system.

e) When the system is initially brought up to temperature, additional pipe scale and welding slag will loosen and enter the fluid stream. This will be trapped in the strainer causing vacuum at the pump suction. This procedure must be followed as necessary in the course of heater operation.

Illustration indicates proper fluid level in the expansion section of the deaerator tank.



10. Firing the Heater/Heater

Pressure Gauges

Warning

During a system boil out, it is imperative that all system legs or paths are open to flow to ensure no water is trapped in the system.

Warning

Never open a cool or unheated user leg of a system when the rest of the system is above 250°F.

a) Check for correct fuel feed. All air must be eliminated from fuel lines, gas piping, preheaters, etc.
b) All manual valves in the fuel oil supply line must be open. Do not run the fuel pump dry or without fuel lines connected to fuel source. Do not allow the fuel oil pump to pull a vacuum.
c) Check safeties.
d) Disable N2 blanket if equipped and open vent line on DA tank.
e) Set control switch to “Heat”. The burner will begin the call for heat if oil temperature is below setpoint.
f) With burner firing and pump running, keep checking the gauges indicating pump and circuit pressures. Make sure they remain stable.
g) In case of pressure fluctuations, stop the burner, but allow the pump to continue to circulate fluid.
h) When pressures have stabilized, start burner again.

i) Continue in this manner up to the maximum operating temperature. Throughout the initial warm-up, the expansion tank and its overflow pipe must be watched to detect the formation of steam, indicating the presence of water. If this occurs, burner should be shut down.

j) If steam is forcing thermal fluid out of the expansion tank vent, turn the heater off, but leave the pump on. This is to circulate the hot fluid through the piping without flushing the steam too quickly. Once steam and thermal fluid stop leaving the expansion tank unit, the heater can be turned on. Increase the temperature very slowly to prevent fluid from being forced out of the tank.

Note

Do not open drain or vent valves during operation.

Note

If excessive amounts of thermal fluid is vented from the system, additional thermal fluid may be required in the system.

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

k) Continue bringing unit up to temperature slowly, with a temperature rise not exceeding 100°F (38°C) per hour. Do not exceed specified maximum outlet temperature. In the absence of specific information, consult the factory before proceeding.

l) Once up to temperature, check the fluid level in the expansion section by opening the high level manual test connection. If a permanent flow of fluid results when this valve is opened, and if all previous precautions have been followed, the expansion tank is too small for the capacity of the fluid in the installation. A larger tank must be installed.

m) After fifty hours of operation at operating temperature, check all flanges and connections for tightness.

Note

Start-up technician should verify that all valves are opened prior to establishing flow and heat-up.

Note

If fluid or piping is added to the system the boil out procedure must be followed, as water has to be introduced into the system.

11. Procedure for First Shutdown

a) The heater system should be shut down after no more than 24 hours of operation at full operating temperature. At this time, the following maintenance items will need to be completed to meet warranty conditions.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer's specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system cooled to ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer's specifications using proper flange torquing practices such as incremental torque increases, star pattern, etc. Refer to Installation Section.

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back into operation, check all gauge readings and compare to values given to you by the start-up technician. Note any discrepancies and contact Fulton.

12. Required Pressure Drop Across the Heater

a) The thermal fluid pressure drop across your heater is critical. This should be recorded at the completion of start-up. The pressure drop value is obtained by subtracting the heater outlet pressure from the heater inlet pressure when the thermal fluid is at normal operating temperature.

b) At the recommended standard flow rates, and .7 sp gr, the pressure drop across the heater should be as shown in the chart at the top right.

c) In the event of an abnormal reading, contact Fulton Service immediately. Failure to take immediate action in the event of reduced fluid flow may result in rapid and serious degradation of the fluid, with possible damage to the heater.

Required Pressure Drop Across the Heater

Model	Recommended GPM (Schedule 40)	Recommended GPM (Schedule 40)	Pressure Drop PSI
FT-0080-C	44	50	25
FT-0120-C	66	75	27
FT-0160-C	88	100	20
FT-0240-C	132	150	30
FT-0320-C	N/A	250	25
FT-0400-C	220	250	25
FT-0600-C	330	375	26
FT-0800-C	440	500	26
FT-1000-C	550	615	18
FT-1200-C	660	730	27
FT-1400-C	N/A	800	27
FT-0400-S	N/A	400	18
FT-0600-S	N/A	600	16
FT-0800-S	N/A	800	19

NOTE: The DP switch should never be set less than 2 psi below the required pressure drop.

13. Burner Cycles

Gas Fired Burners

a) The burner is of forced draft cone design.

b) Pressure regulators on both the pilot and main gas supply, supply pressure to the proper level. Note the maximum inlet pressure rating of each regulator and supply a step-down regulator if required.

c) Combustion air is delivered by a centrifugal blower fan. An air switch monitors the pressure and is part of the flame programmer safety interlock circuit.

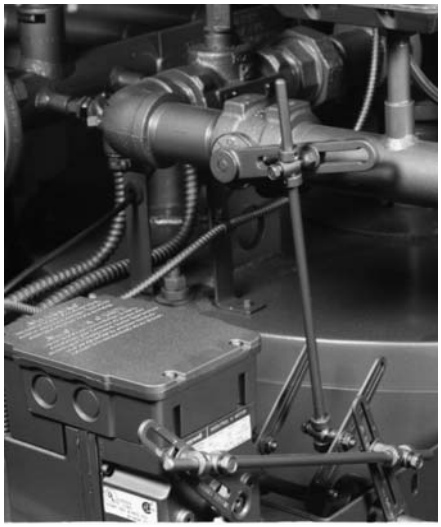
d) The flame programmer monitors the safe operation of the burner. Functions include pre-purge of the combustion chamber, provision of ignition via the ignition transformer and electrode, opening the pilot gas valve, monitoring the pilot flame signal via the flame sensor, opening main gas valves and providing post-purge of the combustion chamber.

e) Ignition of the pilot gas must result in a stable pilot flame before the flame programmer will open the main gas valve.

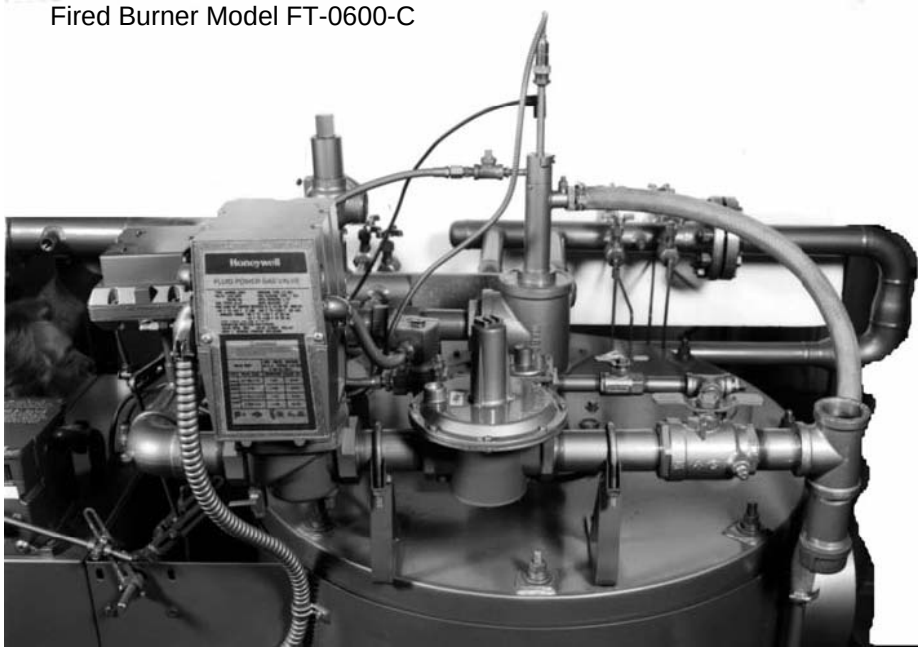
f) The flame is monitored by a flame sensor. In the event of insufficient, unstable, or non existent pilot or main flame, the flame sensor will cause a safety lockout of the flame programmer. Safety lockout can also be caused if the flame sensor is

improperly positioned or grounded. After fault has been corrected, reset by pressing the red push button on the casing of the burner control box.

Top of a Dual Fuel (Gas/Oil) Fired Burner Model FT-0600-C



Modulation Motor



Typical Gas Train for Models FT-0080-C through FT-0240-C

g) Modulating Burner

1. The function of the flame programmer must be greatly extended in a modulated system. Along with limit controls, operating controls and interlock devices, the programmer automatically controls the operation of the burner, blower motor, ignition, main fuel valves and modulating motor.

2. The sequence of operation begins with power on, limit switch and fuel valves closed, and modulating limit controller closed and calling for heat. The flame programmer begins its cycle and the blower motor starts pre-purge. The modulating circuit closes, driving the air dampers to maximum for pre-purge.
3. The air flow proving switch must be closed now. After timed pre-purge, the modulating motor drives the air damper to its low fire position. All start interlocks must be proven or the flame programmer will lockout.
4. (Units with Gas Pilot) Ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, the main fuel valve is energized. Ignition and pilot fuel are turned off and the modulating motor is released to automatic.
5. (Units with Spark Ignition) The spark and oil valves are energized and a timed trial for ignition begins. With the flame proven, the control advances through its main light off sequence, and the ignition shuts off. At this time, with the flame proven, the modulating motor is released to automatic.
6. When the modulating motor is released to automatic, it receives its signal from the modulating temperature controller. The modulating motor then drives the modulating fuel valve and air damper in proportion to the heat demand.
7. During the initial call for heat, the modulating fuel valve and air damper will drive to their full-fire position. As the temperature set point is approached, the modulating motor will continue to reduce the input until low-fire position is reached. Input automatically increases and decreases according to load demand.
8. When the fluid temperature reaches the set point of the on/off temperature controller or of the optional operating limit controller, all fuel valves will close and the flame programmer will advance to the purge cycle. When the postpurge cycle begins, the modulating motor will be in the low fire position. At the end of postpurge, the burner motor stops and the entire system is ready for restart on demand.

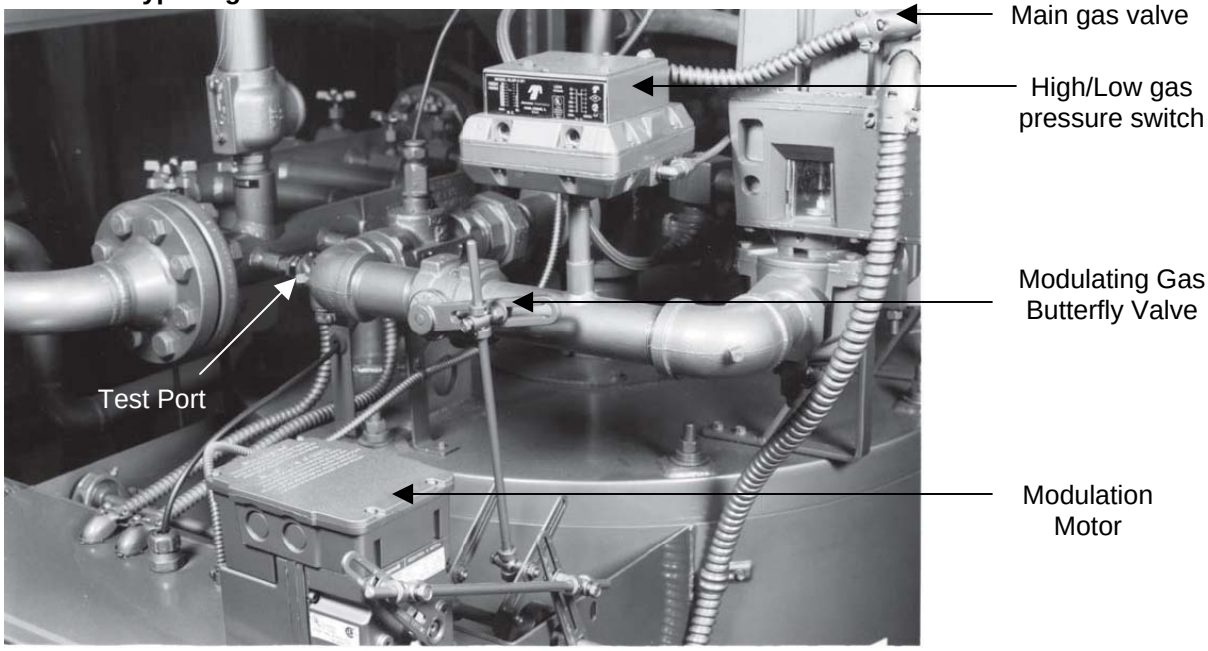
14. Fireye Linkageless Modulation

a) The Fireye Linkageless system takes the place of the Fireye E110, UT-350, Mod Motor, Linkage rods and arms. This control is a microprocessor based on Flame

Safeguard and parallels positioning combustion controller. This control has 3 levels of password protection.

1. The site Pass Code is used by the end customer to make changes to the setpoint and to the PID values of the system.
2. The Adjust Ratio Code is used by a competent burner technician to make adjustments to the air and to the gas based on combustion analysis. In this mode you can also change the setpoint and the PID values.
3. The Commissioning Ratio Mode is used by the factory to setup the parameters that are used in the Nexus control. In this mode you can modify all the parameter settings and set up the profiles for gas/air control.

Typical gas train for Models FT-0240-C and below



15. Nexus Display

a) The top line of the Nexus display shows the oil temperature and mode "Auto/Man". This line can not be changed. It is possible to change the second line of the display by using the Left or Right Arrow key, by pressing the key you will see the following: Setpoint, Fault Number, "If Control is in Fault", Hours Run, Flame Signal "range is 0-100 with a minimum signal of 10" and % of modulation.

b) In the event of a Fault on the Nexus, you will need to Press Fault Mute (Mode) key to reset the control.

c) Site Pass Code and Parameters-Default Value is 154:

1. The site pass code allows the “Adjustment of some parameters”, the default code is 154 and it is adjustable. You will be able to view all the options even though you cannot change them.
2. The options that you can change are the following:
    a. 6.3 Setpoint 1 Control Value
    b. 6.4 Setpoint 1 Proportional Band
    c. 6.5 Setpoint 1 Integral Term
    d. 6.6 Setpoint 1 Derivative Term
    e. 7.1 Setpoint 1 Low Limit Value
    f. 7.2 Setpoint 1 High Limit Value
    g. 7.5 Setpoint 1 Warming Limit
    h. 7.6 Setpoint 1 Warming Time
3. The same for Setpoint 2 if enabled.
4. To change the setpoint you Press Com (Enter) key, enter the Site Pass Code using the Up/Down keys then Press Com (Enter) key.
5. Use the Up/Down keys to advance through the options. Note: Pressing the Button too hard can cause you to skip over an option!
6. Advance through the options until you reach 6.3. Use the Left/Right Arrows to select the parameters then use the Up/Down keys to make the changes required. When a change is made Press Com (Enter) key. Use the Left/Right arrow to leave the parameter, then use the Up key to advance through the option list. To leave the Option parameters, Press Data (Run) key then Press Com (Enter) key.

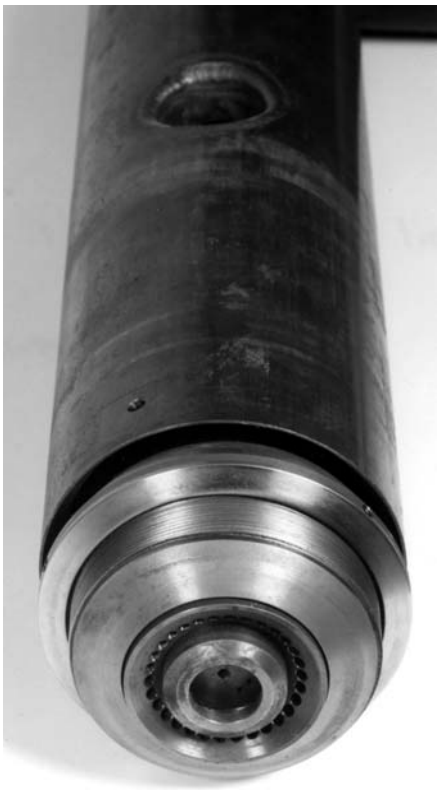
d) Engineers Key

1. The engineers key is a hidden key under the Fireye logo on the display. With the use of the engineers key, it is possible to read the values of the internal system variables and external input and output states. It is also possible to see the values of fault subsets in order to obtain more detailed information about a fault that has occurred.
2. After pressing the Fireye logo use the Up/Down keys to move through the parameters. When using the engineers key it is not possible to change any parameters. To leave this screen, press the Fireye logo and this will bring you out of the engineers parameters.

3. The engineers key parameter list begins on page 55 in the Nexus manual.

e) Nexus Fault Code Display

1. The Nexus 3100 uses the LED lights on the front of the control to provide diagnostic capability to enable the operator to identify faults when they occur. The fault listing begins on page 52 of the Nexus manual.



Oil Nozzle dual fuel burner
Models FT-0600-C through FT-1400-C

Gas Nozzle with orifice dual fuel burner
Models FT-0600-C through FT-1400-C

Complete dual fuel assembly

16. Siemens Linkageless Modulation

a) Setting Pilot

1. Verify the main burner switch is in the OFF position.
2. Supply power to the heater. The AZL will display “system test” and them move to the main menu.
3. Select PWLogin, press Enter. Select AccessServ. Press Enter. (This type of step will be shown as PWLogin – AccessServ for the remainder of this section. Enter the service passwords using the arrow key. The password is case sensitive. The case of a letter can be changed by pressing the other arrow key. (For example, if you used the right arrow key to get to the letter A, press the left arrow key to get a). After you have pressed Enter on the last character of the password, press Enter once more to accept the password. If you do not have the password, contact your Fulton Authorized Representative to perform the changes. Service=NB# or OEM=AAAA (Enter after each A).
4. Select Params&Display. Press Enter. Select Ratio Control. Press Enter. Select ProgramStop. Press Enter. Change the Program Stop to 44 Interv1 by using the arrow keys. Confirm the change by pressing Enter. This will set the burner management system to a ‘pilot hold’ setting.
5. Verify that the current value “curr” changes to 44 Interv 1. The full listing of program stops are:
    a. 24: Air damper in the prepurge position
    b. 32: Traveling to the FGR position (if the unit is equipped with FGR)
    c. 36: Ignition position (before pilot ignition)
    d. 44: Ignition position (after pilot ignition)
    e. 52: Ignition position (after main burner ignition)
    f. 72: Air damper in the postpurge position
    g. 76 – Traveling to the FGR position (if the unit is equipped with FGR)
6. Press Escape 4 times to get back to the main menu.
7. Under ManualOperation – Setload, change the load to 0% by using the arrow keys. Press enter and verify the 0% has been acknowledged in the “curr” field.
8. Press Escape once to get back to the ManualOperation menu.

9. Under Auto/Manual/Off, change the operation to Burner On by using the arrow keys. Press enter and verify that “Burner On” is acknowledged in the current field.
10. Press Escape twice to get back to the main menu.
11. Turn the main burner switch to On position.
12. Increase the set point. Under operation-Heater set point go to set point W1 using the arrow key then press Enter. Change the set point under new, using the arrows and press Enter. The new set point should appear under actual and displayed in degrees.
13. After several seconds the burner control will start its pre-ignition phase and the blower will start.
14. You can observe the status of the burner by going to the main menu (by pressing Escape) then selecting OperationalStat – NormalOperation.
15. The unit will purge then drive to the ignition position and the pilot should light.
16. The burner control will stay at this pilot hold stage so you can inspect and adjust the pilot as needed.
    a. The pilot gas pressure should match the test fire sheet.
    b. The flame signal should be greater than 90% when viewed from the top menu of the Siemens AZL display.
17. Once the pilot is adjusted properly and you are ready to light the main burner, press Escape to the main menu.

b) Setting Main Burner Ignition

1. Under Params&Display – RatioControl – ProgramStop, change the Program Stop to 52 Interv2. This is the main burner ignition position. Press enter and confirm that 52 Interv2 is acknowledged in the current field. This change moves the control to the main burner ignition point in the burner sequence.
2. This will allow the main burner to ignite. Should the burner not light, the gas and air servo motors are not synchronized to produce a combustible mix.
    a) Turn the ON/OFF switch on the panel box to OFF.
    b) To reset the alarm: Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light should go out.

c) To change the setting, return to the front menu by pressing Escape until you are to the main menu. Then select Params&Display – RatioControl – GasSettings – SpecialPositions – IgnitionPos, adjust the gas servo position by using the arrow key to move down to Gas servo if needed. Press Enter to select the servo. Move the gas servo to its new position with the arrow keys. Press Enter to confirm the new value. Use the down arrow to move to the air servo setting if needed. Press Enter to select the servo, use the arrow keys to set the new value. Press Enter to confirm this.

d) Switch the ON/OFF switch back to ON. The heater will re-start.

The light off point for main flame can be set at a higher input than low fire.

3. Press Escape 6 times to get back to the main menu.
4. You can observe the status of the burner by going to OperationalStat – NormalOperation.
5. Verify that the flame signal on the display is great than 90% and check combustion. Adjust the burner to match the test fire sheet for main burner ignition. The procedure described in step 2c is used.
6. Once the ignition position has been adjusted properly, you are ready to check the burner throughout its modulation range. Press Escape twice to get back to the main menu.

c) Setting Main Run Modulation

1. Upon releasing the heater to main run modulation (step 3), the heater will drive to low fire.
2. It is necessary to set combustion through the entire range of modulation first to enable high fire to be reached. Once high fire is achieved, the incoming gas pressure can be set. Fine-tuning of the servo setting throughout the range should be performed only once high fire settings are confirmed.

Note

If the burner loses flame while driving to a point then:

- **Turn the main ON/OFF switch to OFF. Reset the loss of flame fault. Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light on the panel box door should go out.**

- **Adjust the air and gas servos for that point while the burner is off. Follow steps d1-d2 below.**
- **Turn the main ON/OFF switch to ON.**

3. Under Params&Display – RatioControl – GasSettings – ProgramStop, change the program stop to deactivated by using the arrow keys. Confirm that 'deactivated' is acknowledged in the current field.
4. This change will allow the burner to modulate. The burner will now drive to low fire.

Remember, it is only important at this stage to set low fire to be stable and with clean combustion. Exact setting is to be performed once high fire is confirmed.

5. Press Escape 5 times to get back to the main menu.
6. You can observe the status of the burner By going to OperationalStat/NormalOperation.
7. Verify the flame signal on the display, measure input if gas meter is available. If not, match last elbow pressures and combustion for test fire sheet. Adjust the burner as needed.

To adjust the servo position, follow steps 1-2 below.

d) Setting Low Fire

Note

As soon as a servo position is altered, the servo will move to that position. Only change servo settings by a maximum of 0.5° at a time before verifying combustion.

1. Go to Params&Display – RatioControl – GasSettings – CurveParams.
2. Wait for the spinning line on the left to disappear. Press Enter. The number 1 should appear to the right of the cursor, this is the Point Number.
3. Press Enter once. Select ChangePoint by pressing the arrow keys to highlight and then press Enter to select. This will cause the servo motors to move to this low fire point.

4. Check combustion and adjust the servo motors as required. To adjust a servo motor, arrow to it and press Enter. Then adjust the setting as required and press Enter. You can now adjust another servo motor if needed.
5. When combustion is properly set for that point, press Escape once more. If it asks you to store the point, press Enter. Note the AZL will only ask to save if either servo value has been altered.
6. Low fire is now set and stored.

e) Setting the Complete Range

1. Remember it is only necessary to approximate the setting through the modulation range until high fire conditions are established.
2. Press Enter once more to have access to the point number field. Increase the point number by one and press Enter. Select ChangePoint and press Enter. The servos will now move to that point.
3. Verify combustion is satisfactory.
4. Measure input or monitor last elbow pressure. Verify that these points are in general correspondence with the test fire sheet. Repeat step 2 until the point position has a load value of 100%. You are now at high fire. Verify combustion is per test fire sheet.
5. Once at high fire, adjust the incoming gas pressure at the main gas regulator to match the test fire report. Adjust the gas servo motor to change the last elbow pressure to match the test fire report. Adjust the air servo motor to adjust the emissions as needed.
6. Repeat step d1 but start at the high fire point number. Continually decrease the point number after combustion has been verified at each point.
7. Once all the points have been verified, press Escape until you are back to the main menu.
8. You can observe the status of the burner by going to OperationalStat – NormalOperation.
9. Turn the main ON/OFF switch to OFF. The control will now postpurge.
10. Follow steps 16a3-17 and b1-4 again to verify ignition with the new gas pressures.
11. Turn the main burner switch to OFF. The control will now post purge.

12. Under Manual Operation – Auto/Manual/Off, change the operation to Automatic and press Enter and confirm Automatic is entered in the current field.
13. Press Escape twice to get back to the main menu.
14. Under Updating – ParamBackup, select LMV51 – AZL. This will store all of the adjustments that have been made in the LMV base module to the display. If the base module fails in the future, the display can be used to download all of the parameters into a new base module.
15. The heater is now ready to run. Adjust your setpoint on the temperature control to the desired temperature and turn the main ON/OFF switch to ON for the burner to operate.

f) Before Leaving the Installation

1. Check all controls to insure they are operating properly. Cycle the heater several times by raising and lowering operating temperature on the thermostat.
2. Make sure the installation complies with all applicable codes.

g) Changing Set Point on the AZL

1. Hit ESC to Select Operation than hit enter and scroll to Heater Set point, hit enter to Set point W1 hit enter and enter new set point with Select buttons.
2. Done hit enter than ESC 3 times to Operational Stats hit enter to Normal Operation, hit enter to main screen.

h) For Manual Operation

1. Hit ESC and scroll to Manual, hit enter to Auto / Manual / Off, change to manual and hit ESC to Set Load, change to 0 or desired load range with the select buttons.
2. Done hit ESC and scroll to Operational Stats, hit enter to Normal Operation, hit enter to main screen.
3. To return back to Auto operation repeat step 1 & 2.

i) Replacing a Servo Motor

1. If it is determined that a servo motor needs to be replaced, the first step in this process is to verify the model number of the new servo motor is the same as the old servo motor.
2. The model number starts with the letter SQM and is displayed on a label on the side of the motor. Once the new motor has been verified to be correct, turn power to the heater off.
3. Turn off all electricity to the heater.
4. Remove the cover on the servo motor to be changed.

5. Remove the green wiring plugs and the conduit termination point from the motor by pulling them towards you. A black grounding wire runs from the motor to the conduit termination point. Pull it off from the conduit termination point.
6. Also note the location of the jumper of the left side of the motor.
7. Loosen the allen screws on the motor end of the motor end of the motor to valve coupling.
8. Unbolt the motor from the mounting bracket and remove the motor.
9. Turn the valve so it is in the closed position and can rotate clockwise to open.
10. Mark the coupling or valve shaft if needed so the position of the valve can be determined when the servo motor is installed.
11. Bolt the new servo motor on to the mounting bracket with the motor shaft inserted into the coupling.
12. Rotate the valve shaft/coupling assembly closed as stated above.
13. While holding the valve closed, tighten the allen screws on the coupling.
14. Install the wired green wiring plugs and the conduit termination point on the new motor. Connect the black grounding wire form the motor to the conduit termination point.
15. Verify the jumper on the motor is located on the same pins as the motor that was replaced.
16. Turn power to the heater on.
17. The screen will display ‘system test’. The fault “Fault Feedback Air Actuator’ will be displayed. DO NOT RESET THIS FAULT YET. Press Escape twice to clear the fault from the screen.
18. Press Escape to get to the main menu. Under Params&Display – Actuators – Addressing, select either the gas actuator or air actuator depending upon which was replaced. The control will run an actuator check then display ‘Start Address Assignment with ENTER’. Press Enter. The display will then have you press the addressing button on the actuator. This is the red button on the actuator. The screen will then display ‘Actuator Address Assignment Successful’.
19. Press Escape until the main menu is reached. Under OperationStat – Status/Reset, reset the fault.

Caution

The heater emissions may not be correct after changing the servo motor. Verify the emissions throughout the range of modulation. If emissions are off, the servo motor can be adjusted by following the procedure in the Commissioning the Heater section of this manual.

17. On/Off Burner

a) The sequence of operation begins with power on, limit switch and fuel valves closed, and temperature controller calling for heat. The flame programmer begins the cycle and the blower motor starts prepurge.
b) The air proving switch must be closed now. Air dampers remain in maximum position.
c) (Gas Pilot) Provided all safety interlocks are proven, ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, the main fuel valve is energized. Ignition is turned off after main flame is established.
d) (Spark Ignition) Provided all safety interlocks are proven, the spark is on and oil valves are opened. When the flame is proven, the spark is shut off.
e) When the fluid temperature reaches the setpoint of the operating temperature controller, all fuel valves are closed.
f) The burner motor stops and the entire system is ready for restart on demand.

18. Oil Fired Burner

a) The following refers to the design and operation of the on/off burner utilizing fuel oil which requires no preheating. This burner is of high pressure, mechanical atomization design.
b) An oil pump is used to obtain necessary atomizing pressure before the fuel oil reaches the nozzle.
c) The fuel oil is divided into fine particles in the nozzle and imparted with a rotating motion before escaping from the nozzle as a cone of finely atomized oil.
d) Combustion air is supplied by a centrifugal fan. A damper provides throttling of the inlet opening. The air from the fan reaches the burner head after going through a turbulator, accomplishing correct distribution and mixture of air and atomized fuel oil.
e) An electric spark between two electrodes provides ignition of the atomized mixture, except where code requires a gas pilot. This spark is produced by a high voltage transformer.

f) The flame programmer circuit controls normal operation of the burner. The sequence includes purging of the combustion area for a set period, ignition and opening of magnetic valves on the oil circuit; post-purge of combustion area and return to re-start position.

g) An ultra-violet scanner mounted on the burner casing and facing the light of the flame monitors the flame.

h) Safety lock out occurs within a preset minimum time in the event of insufficient, unstable or non-existent flame. After fault has been corrected, reset programmer by depressing the red push button on the casing of the burner control box.

i) Proper fuel pressure at the burner nozzle is essential. The correct firing rate is obtained by setting the fuel oil pump to give the design pressure for each unit. This is done at the factory.

j) Pressure is measured by connecting a 0-400 PSI (0-25 bar) test pressure gauge to the gauge connection on the fuel pump. The fuel pressure gauge indicates the pressure of the fuel at the burner nozzle.

k) Typical pressures range between 160-350 PSI (12-22 bar). Note the correct setting upon commissioning. Modulating units should have a second pressure gauge monitoring the pressure in the return pipe from the burner. This gauge will indicate the variation of oil flow caused by modulation of the burner. Gauge readings should be recorded at start-up and checked periodically.

19. Dual Fuel Burner

Changing Fuel

a) The following instructions apply only to units supplied with dual fuel burners. These procedures should be performed only when the fluid is cold, unless sufficient safeguards are provided to prevent contact with hot fluid piping in the vicinity of the burner.

b) Set the fuel switch to "Off" and the heat selector switch to either "Pump" or "Off".

c) Gas to Oil

1. Turn off the manual gas cocks in the gas train. Remove the gas nozzle orifice assembly from the burner. Install the oil nozzle assembly and attach the oil whips to the assembly. Open all oil manual shutoff valves.

d) Oil to Gas

1. Turn off all oil manual shutoff valves. Detach the oil whips and remove the oil nozzle assembly. Install the gas nozzle orifice assembly and open the gas cocks in the gas train. Reset the hi/low gas pressure switch.

2. Set the fuel selector switch to the proper fuel. Restart unit normally.

20. Operating Controls

a) The following specifications, data, equipment and operating descriptions apply to typical Coil Design units. These sections are provided for general information purposes only, and do not necessarily reflect the specific details of individual systems.

b) *Liquid Level Switch-When Combination Tank is Supplied*

1. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Control power will be lost to the panel.
2. To confirm operation, manually trip the liquid level switch. Unit should shut down; pump will stop.

Combination Deaerator/Expansion Tank

c) Air Safety Switch

1. This switch requires that the blower fan deliver combustion air before energizing any fuel valves.
2. While firing, disconnect the copper line from the fitting in the top cover of the air switch. The burner should shut down. Attempt to restart the unit by resetting the flame programmer.
3. Blower motor will start, but firing sequence should not begin.

d) Blower Motor Starter-For units equipped with manual trip test button or motor starter

1. While firing, actuate the manual trip button on blower motor starter. Unit should lock out. Attempt re-start by resetting the flame programmer. Purge cycle will not begin.

2. Reset motor starter; blower should start and purge cycle will begin.

e) Differential Pressure Switch

1. The heater is dependent on proper flow for operation; therefore, a differential pressure switch is used to sense the pressure drop across the heater. The differential pressure switch will shut the unit down in the event of loss of flow.
2. The differential pressure switch can be tested while only the pump is running. Remove the metal cover on top of the switch and increase the setpoint until the pump shuts down. Next, decrease the setpoint back to its initial value and depress the pump start button to verify the pump will re-start.

Differential Pressure Switch

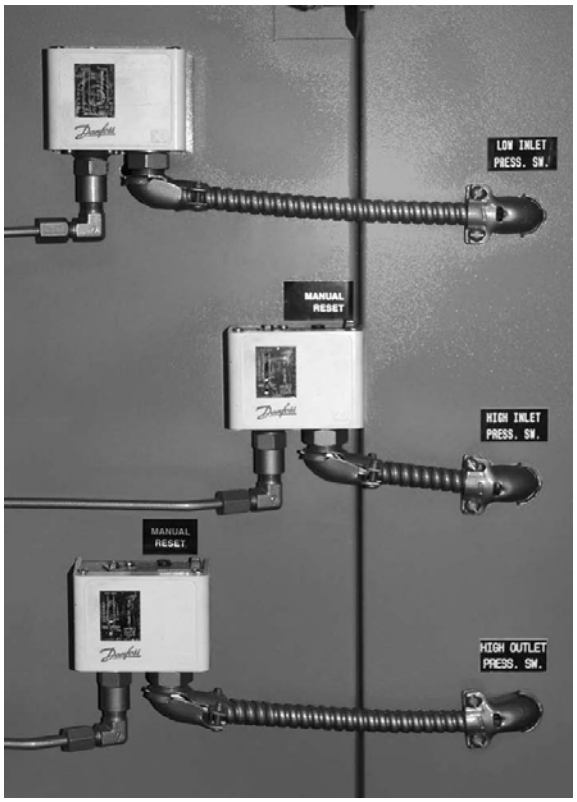
f) Pump Motor Starter

1. While firing, actuate the manual trip button on the pump motor starter. Pump and burner will shut down. The blower should continue to run for approximately thirty seconds. Attempt to restart pump by setting the selector switch to “Pump” and depressing the pump start push button. The pump should not start. Reset starter and start pump.

g) High and Low Fluid Pressure Switches

1. The only pressure required in the thermal fluid system is the pressure required to maintain the proper flow. Pressure changes are monitored with these switches, which will shut the unit down in case of a change in the fluid flow.

2. With three position switch set to “Pump”, remove the cover from the pressure switch and manually activate. Pump should shut down.
3. Repeat for each switch; replace covers. Note, if the burner was on, it would also stop.
4. To set the low fluid pressure cutout switch, raise the setpoint with the fluid at operating temperature and pump running, until the pump shuts down. Note the setpoint and lower by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the reading on the output pressure gauge.
5. With the unit cold and pump running, lower the high fluid pressure cutout switch until the pump shuts down. Note the setpoint and raise by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the inlet gauge reading.

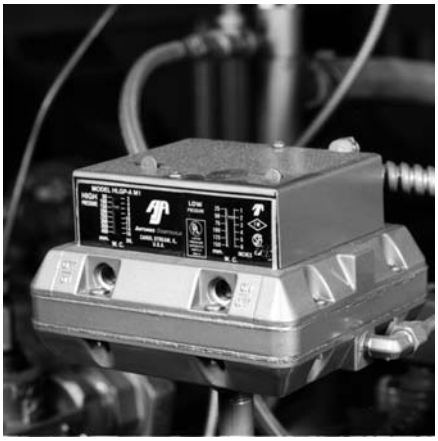


High/Low Fluid Pressure Switch

h) Gas Pressure Switch-Gas Fired Units Only

1. While firing, shut main gas cock.
2. Unit will lock out.
3. Attempt restart by resetting flame programmer.
4. Unit will start purge and lock out.

5. Open main gas valve and reset flame programmer.
6. Reset high side of switch, unit will start purge and fire.



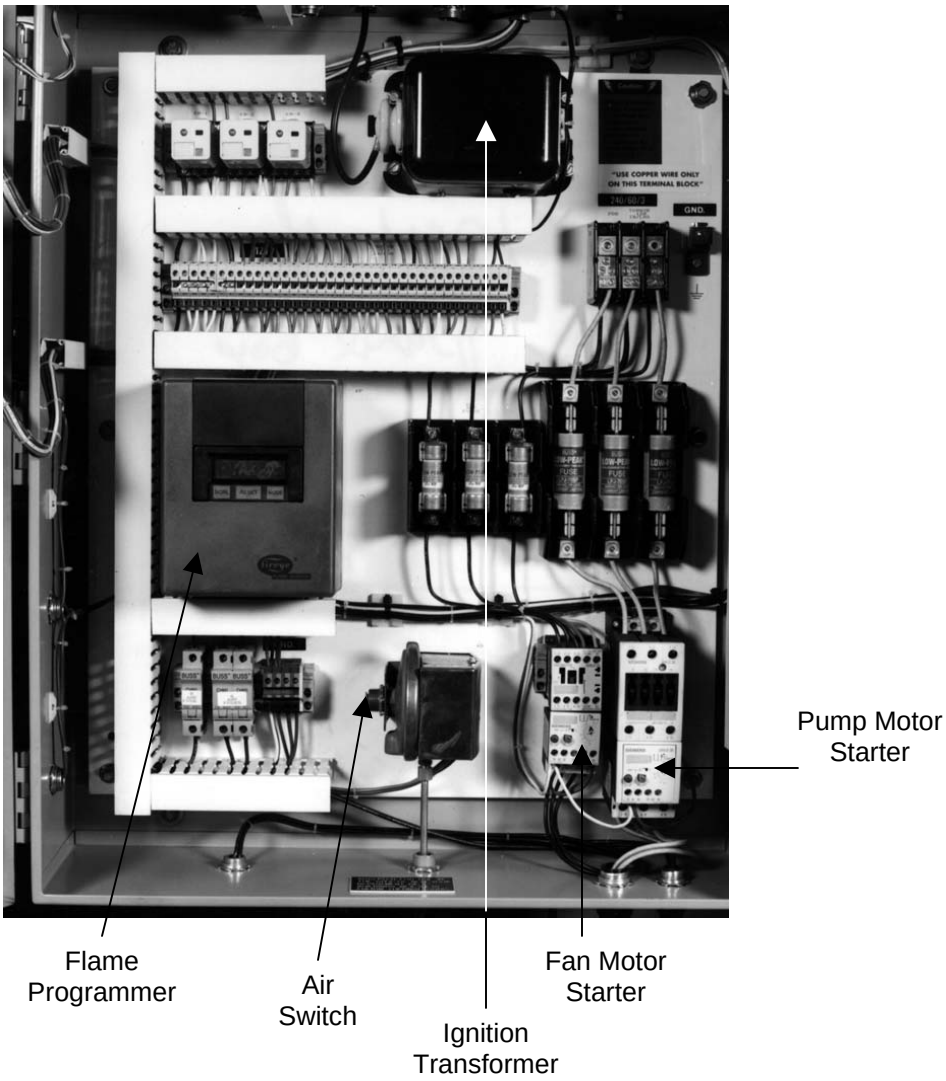
High/Low Gas Pressure Switch

i) Operating Temperature Controls

1. The Coil Design unit is a fired heat exchanger and the safe control and monitoring of the thermal fluid temperature is of vital importance. The safe maximum temperature of the fluid must be strictly adhered to.
2. When consulting fluid manufacturer's literature for the safe maximum fluid temperature, note that the temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a "film" temperature which is higher than the temperature of the bulk of the fluid.
3. Temperature controllers measure the bulk temperature and not the film temperature. This must be taken into consideration when setting the temperature controls.
4. These approximate guidelines for temperature settings are not to override the system design parameters.
5. These instructions should be used with information from the system designer. Manufacturer's literature on the temperature controller is provided in the last section of this manual.
6. Standard primary temperature control sensing point location for On/Off and Modulating heaters is on the heater outlet.
7. When optional inlet location of the primary controls is specified. the following instructions may still be used with some modification. For instance when primary controls are located on the inlet, the dead band range will be much narrower than on

heaters with outlet control. In addition, temperature changes will not be as immediately apparent.

8. An indicating temperature controller is used to regulate the thermal fluid temperature. Typically the indicating control is a thermocouple.
9. The thermocouple is directly immersed in the thermal fluid in the heater manifold. The setpoint of the controller is regulated by the keypad.



j) High Temperature Limit Switches Safety (All units)

1. All units are fitted with high temperature limit controllers which monitor the fluid temperature at the heater outlet. This limit controller provides over temperature protection. A high temperature limit switch acts as an over temperature safety

device. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed. The red button on the flame programmer must also be pressed to reset the unit before it can be restarted. The high temperature limit controller is factory set to 0°F. This must be set to the lowest of the following:

a. Maximum operating temperature of the fluid.
b. Maximum operating temperature of the equipment.
c. 15°F over maximum system operating temperature.

2. Do not set this controller too close to the normal outlet temperature in order to avoid nuisance lockouts due to small transient over temperatures.
3. Several consecutive lockouts caused by the high temperature limit controller indicate the need for immediate installation review, beginning with fluid level in the expansion tank, firing rate, and circulating pump performance.

k) Operating Limit Controller

1. The limit controller is mounted in the panel box door. This limit controller senses temperature in the outlet manifold. The temperature setpoint in the controller can be adjusted following instructions in the component data sheet section of this manual.

l) On/Off Controls

1. Typically one controller is provided to sense the temperature on the heater outlet. This controls the operation of the heater by switching it on and off. An adjustable two point differential between shut off and start up is built into the controller. This prevents frequent cycling of the burner. The controller is set to provide the desired outlet fluid temperature.
2. Due to the temperature rise through the unit, this may be considerably higher than the inlet temperature.
3. If the unit is equipped with an on/off controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the instructions in the component data sheets section of this manual.

m) Modulating Controls

1. All coil models are standardly equipped with modulating controls.
2. The modulating temperature controller continuously regulates the outlet fluid temperature between the minimum firing rate and high fire. When the unit is on low fire and the temperature

continues to climb past the setpoint, the heater will shut down. It will typically re-start when the process temperature drops 7°F below setpoint.

3. Minimum load depends on the degree of modulation provided. Typically 3:1 or 5:1 modulation is provided. In this case minimum load is one third of full firing rate.
4. The modulating temperature controller is set to maintain the desired fluid outlet temperature. Due to the temperature rise across the heater, this may be considerably higher than the inlet temperature.
5. If the unit is equipped with a modulating controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the instructions in the component data sheet section of this manual.

n) Additional Modulating Controls

1. The modulating motor is controlled by a temperature controller located in the control panel. Its function is to drive modulating fuel valves and air damper to their correct position as dictated by the flame programmer during pre-purge and post-purge, and to correctly position both during the normal firing cycle as required by the proportioning temperature controller. A modulating valve is positioned in the main fuel line to control the fuel input according to demand by the modulating motor.

o) Pressure Gauges

1. All units have two pressure gauges measuring the thermal fluid pressure at the inlet of the heater and at the outlet of the heater. The difference between the readings of the two gauges indicates the pressure loss across the heater. The difference must not fall below the recommended value. Recommendations are based on heater size and are listed in Section Two.
2. The gauge indicating the pressure of the fluid at the inlet is labeled “Inlet“. The “Outlet” gauge indicates the pressure at the outlet, and in effect indicates the resistance of the external pipework circuit. The pressure gauge indicating pressure at the inlet of the pump is labeled “Suction .”

p) Flow Proving Device

1. The heater is dependent on proper flow for operation; therefore, three pressure switches and a differential pressure switch are

used to sense flow across the heater. Any one of these switches will shut the unit down in the event of loss of flow.

21. Daily Start-Up

a) Check positioning of all system valves to ensure flow is not dead-headed.
b) Visually check relative position of minimum level float switch in the combination tank.
c) Turn on power supply switches.
d) Where applicable, open water cooling valve and check that water flows correctly. (For water cooled pumps only.)
e) Open fuel valves.
f) Set three position switch to “Pump”. Push and hold manual pump start button, monitoring pressure gauges on heater.
g) Push reset on high fluid pressure switch located on the side of the control panel. Release pump start switch. Pump should continue to run.
h) When ready to begin heating, move three position switch from “Pump” to “Heat”. After a short delay resulting from the purge period, the burner will ignite. Make sure that the temperature setpoint is as desired.
i) On gas units, pilot valve activation will be indicated after pre-purge cycle has completed, followed by main flame activation. Check the presence of the flame by observing flame signal strength from flame programmer or testing device. Operator attendance during warm-up is a recommended precaution.
j) Start-up is considered complete when the unit begins to throttle back or shutdown on target temperature.

22. Daily Shutdown

a) Set control switch to “Pump” pump running, burner off.
b) Allow the fluid to circulate for approximately 20-30 minutes and then set the control switch to the “Off” position.
c) When using fluid cooled pump, continue to circulate cooling water to pumps for 30 minutes after stopping circulation.
d) Open power supply switches.
e) Units switched off by an automatic time switch should have an extra relay fitted to allow 20-30 minutes of fluid circulation after stoppage in order to prevent localized over heating of fluid .
f) Close fuel valves if required. Closing of system valves is not generally necessary unless maintenance of components requires a partial draining of the system.

g) Because of the high temperatures usually applied, leaks are not expected to occur when cool down is achieved, provided pipework is free to contract naturally when cold.

Section 4

Section 4 – Maintenance

Minimum equipment necessary to start and maintain fuel-fired thermal fluid heaters:

- Digital Multimeter
- Combustion Analysis Equipment
- Draft Gauge

1. Required Maintenance at First Shutdown

a) The thermal fluid system should be shut down after no more than 24 hours of operation at operating temperature. At this time, the following maintenance items will need to be completed to meet the condition of warranty.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system at ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer specification using proper flange torquing practices (incremental torque increases, star-pattern, etc). These values are available in the installation section of the manual..

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back in operation, check all gauge readings and compare to values given to you by the start up technician. Note any discrepancies and contact manufacturer.

2. General Maintenance Schedule

Daily

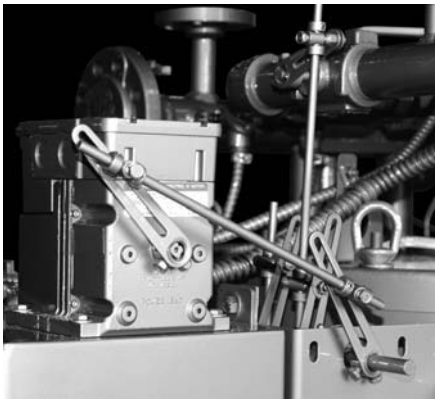
a) Complete the log sheet attached at the end of this section at least once per day as a minimum. It is recommended that the log sheet be filled out twice per shift of operation. The log sheet is available from the Fulton Service Department or www.fulton.com

b) Make visual inspection of the entire system for leaks. Make repairs as soon as possible.

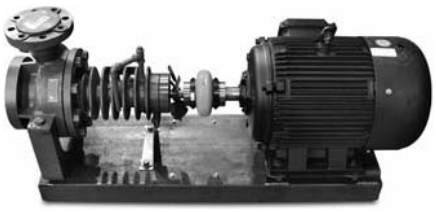
c) Note any failures on the flame programmer noting fault number, fault code, fault annunciation, fault hour, fault cycle and fault time.

d) Check the exhaust for the presence of smoke. If smoke is present, contact Fulton Service Department at (315) 298-7148 or contact your local Fulton Thermal Representative.

e) In systems utilizing linkage, check all linkage components for tightness.

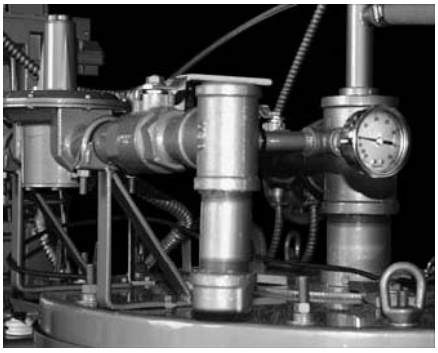


f) In systems utilizing a water cooled thermal fluid circulating pump, check level of lubricating oil in self-leveling reservoir and check cooling water circulation loop for proper operation.



Weekly

a) Check inlet gas pressure at the beginning of the gas train. This should be accomplished by the installation of an appropriately scaled gauge.

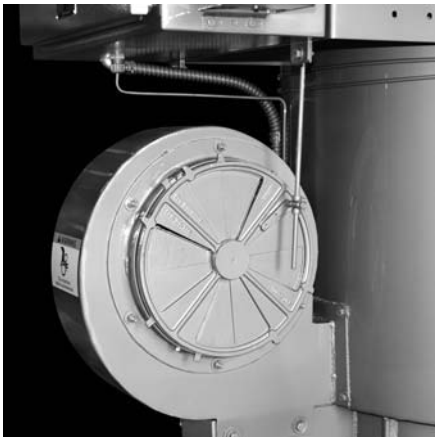


b) Check manifold gas pressure at high and low fire and compare to Thermal Combustion Checklist filled out by start up technician. This should be accomplished by the installation of an appropriately scaled gauge. Readings should be with .02" w.c. of Thermal Combustion Checklist.

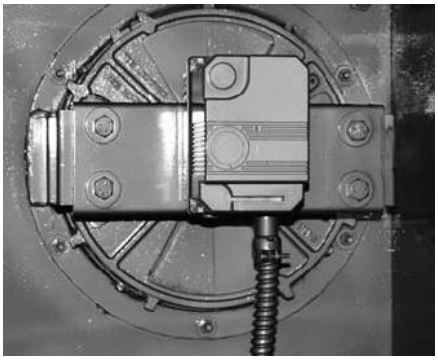
Monthly

a) Clean fuel filters.

b) Check burner blower. Clean if necessary.

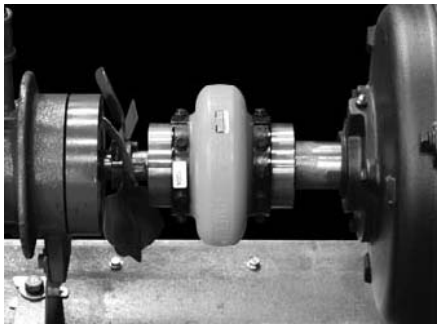


c) Clean or change air filter if applicable.



d) Manually check fluid level in the expansion tank. Drain ½ gallon of thermal fluid from the expansion tank. If water is present, continue to drain ½ gallon until no water is present.

e) Check operation of all safeties. Refer to the instructions at the end of this section.
f) With the burner running, remove or disconnect the flame detection device. The flame programmer should lockout within 3 seconds.
g) Review daily log sheets noting any deviations from the norm.
h) Check the tightness of all couplings, including the fuel oil pump drive (oil-fired units), fan impeller, circulating pump, etc.



Semi-Annually

a) Pull burner and inspect for heat stress or soot. Clean or replace as necessary.

b) Inspect pilot tube assembly and ignition electrode. Clean or replace if necessary. Reset ignition settings to manual specifications.

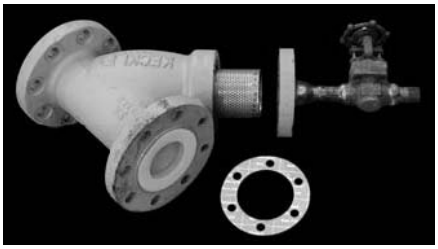
c) Inspect internal surfaces of the heater. Inspect refractory for cracks. Cracks larger than ¼" wide will require repair or replacement of the refractory. Inspect coil for sooting. If soot is present, it can be removed by utilizing a brush or compressed air for light sooting.
d) Have combustion checked for efficiency.
e) Review daily log sheets noting any deviations from the norm.

Annually

a) Replace the ignition electrode(s).

b) If the unit utilizes a flame rod, replace.

c) Clean all strainers in the thermal fluid system.



d) Take a one quart sample of thermal fluid and return to the thermal fluid manufacturer for analysis.

e) Schedule to local Fulton representative or factory service technician to perform an annual preventative maintenance.

3. Maintenance Procedures

Lubrication

a) Different motor manufacturers recommend various intervals for lubrication schedules. Load variations will dictate the frequency and amount of lubrication required.

b) When developing your lubrication schedule, consider the thermal fluid pump and all system pumps.

c) If you have a thermal fluid circulating pump with a packed seal, the condition of the pump packing should be checked regularly. If fluid leakage increases, tighten the packing ¼ turn daily.

Soot Cleaning

a) If your coil inspection indicates severe sooting, the following procedure should be followed:

1. Drain fluid from the coil (using a pump).
2. Remove the burner and lower access doors.
3. Wire brush coils and use compressed air where accessible.
4. Vacuum loose soot where accessible.
5. Reinstall the burner and lower access doors.
6. Fire the heater to roughly 300°F.
7. Remove the burner again and fill the heater with a water/detergent or water/caustic mix to the flue outlet. The water to caustic mix should be at a ratio of 25 gallons to one pound of caustic soda. The amount of caustic for each heater is as follows:

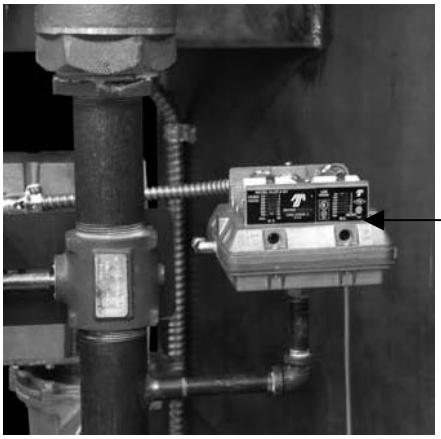
Heater Size	Pounds of Caustic Soda
FT-0080-C	1
FT-0120-C	1 ¼
FT-0160-C	1 ½
FT-0240-C	2
FT-0400-C	3
FT-0600-C/FT-0400-S	4
FT-0600-S	4
FT-0800-C/ST-0800-S	5
FT-1000-C	6
FT-1200-C	7

8. Stir the mixture occasionally and let the wash continue for at least one hour.
9. To drain the heater, pump out. Rinse heater thoroughly when finished before reassembling heater.

4. Safety Check Procedures

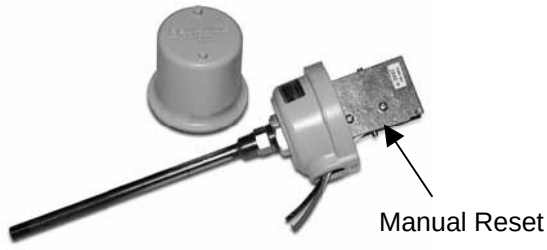
Liquid Level Switch

a) Manually turn liquid level switch cam counterclockwise. Micro-switch will open contacts and control voltage will be lost. Release cam and micro-switch will make and control voltage will be restored.



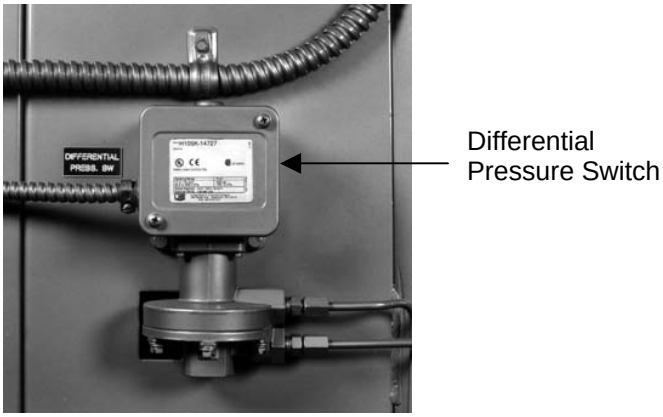
Stack Limit

a) The limit manufacturer presets the stack limit. Testing can be performed by removing switch from stack and applying heat over that of the switch set point for several seconds. The switch can then be reset and re-installed.



Differential Pressure Switch

a) With the circulating pump running, observe the difference in pressure between the heater outlet gauge and the heater inlet gauge. Remove the top cover of the differential pressure switch. Note the original setting of the switch and turn adjustment knob clockwise until switch trips. The pointer on the switch should be within 2 psi of the observed pressure difference. Reset switch to the original set point.



Low Inlet Pressure Switch

a) Slowly close the valve on outlet of main circulating pump observing heater inlet pressure gauge. Note the pressure at which the switch trips. This pressure should be roughly the set point of the switch minus any differential that is set.

High Inlet Pressure Switch

a) Note the original setting of the switch and turn adjustment screw counterclockwise while observing heater inlet pressure gauge until switch trips. The pointer on the switch should be within 2 psi of the observed pressure. Reset switch to the original set point.

High Outlet Pressure Switch

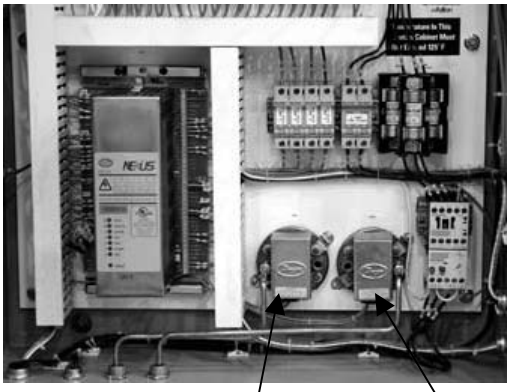
a) Note the original setting of the switch and turn adjustment screw counterclockwise while observing heater outlet pressure gauge until switch trips. The pointer on the switch should be within 2 psi of the observed pressure. Reset switch to the original set point.

Air Switch

a) Remove the ¼" copper tubing from the bottom of the air switch with the fan running. Air switch should trip the interlock circuit. Re-attach copper tubing and reset flame programmer.

Air Filter Box Switch

a) With heater running at high fire, block opening to air filter box by 50%. Slowly close off further until switch trips. Air switch should trip at just over 50% blockage.



Temperature Limit(s)

a) Adjust set point(s) of temperature limit(s) down to a point lower than the PV (process variable is typically the current fluid temperature at the heater outlet). Solid-state controls will deactivate a control relay powering a set of n.c. contacts in the interlock circuit. Analog controls will open their contacts in the interlock circuit. Trip temperature should be within 5 degrees of PV temperature. Reset temperature limit if reset exists and reset flame programmer.

High/Low Gas Pressure Switch

a) Shut off the main gas valve prior to the gas train and attempt to light the unit. After the gas valves open during the ignition trial, the low gas pressure switch will trip. Reset the low gas pressure switch and flame programmer. Open main gas valve prior to gas train and close gas valve between last actuated gas valve and burner. Attempt to light the unit. After the gas valves open, the high gas pressure switch will trip. Reset the high gas pressure switch and the flame programmer.

5. Recommended Maintenance Schedule (See log sheet)

Daily

a) Complete log-sheet at least once per day. Twice per shift of operation is recommended. (Log sheet is available from the Fulton Service Department or on the web at www.fulton.com)

b) Make visual inspection of entire system for leaks. Repair as soon as possible.

c) Note any failures on flame programmer noting fault number, fault code, fault annunciation, fault hour, fault cycle, and fault time.

d) Check the exhaust for the presence of smoke. If smoke is present, contact Fulton Service Department (315) 298-7148 or your local Fulton Thermal Representative.

Weekly

a) Check inlet gas pressure at beginning of gas train. Appropriately scaled gauge should be installed to facilitate this.

b) Check last elbow gas pressure at high fire and low fire and compare to Thermal Combustion Checklist filled out by start up technician. Appropriately scaled gauge should be installed to facilitate this. Readings should be within 0.2" w.c.

Monthly

a) Clean fuel filters.

b) Check blower fan. Clean if necessary.

c) Clean or change air filter if installed.

d) Manually check fluid level in expansion tank.

e) Check operation of all safeties. Contact Fulton service department for instructions.

f) When the unit is running, disconnect the flame sensor. Heater should shut off on flame failure immediately (within 3 seconds).

g) Review log sheets and note any deviations from the norm.

h) Drain ½ gal. Of oil from thermal buffer section of DA tank.

Semi-Annually

a) Pull burner and inspect for heat stress or soot. Clean or replace if necessary.

b) Inspect pilot tube assembly and ignition electrode. Clean or replace if necessary. Reset ignition settings to manual specifications.

c) Inspect refractories for cracks. Make sure there are no pieces of refractory loose on the bottom of the unit. Cracks 1/8" wide can be patched. If cracks are ¼" or larger, refractories need to be replaced.

d) Review log sheets and note any deviations from the norm.

e) Have combustion checked for efficiency.

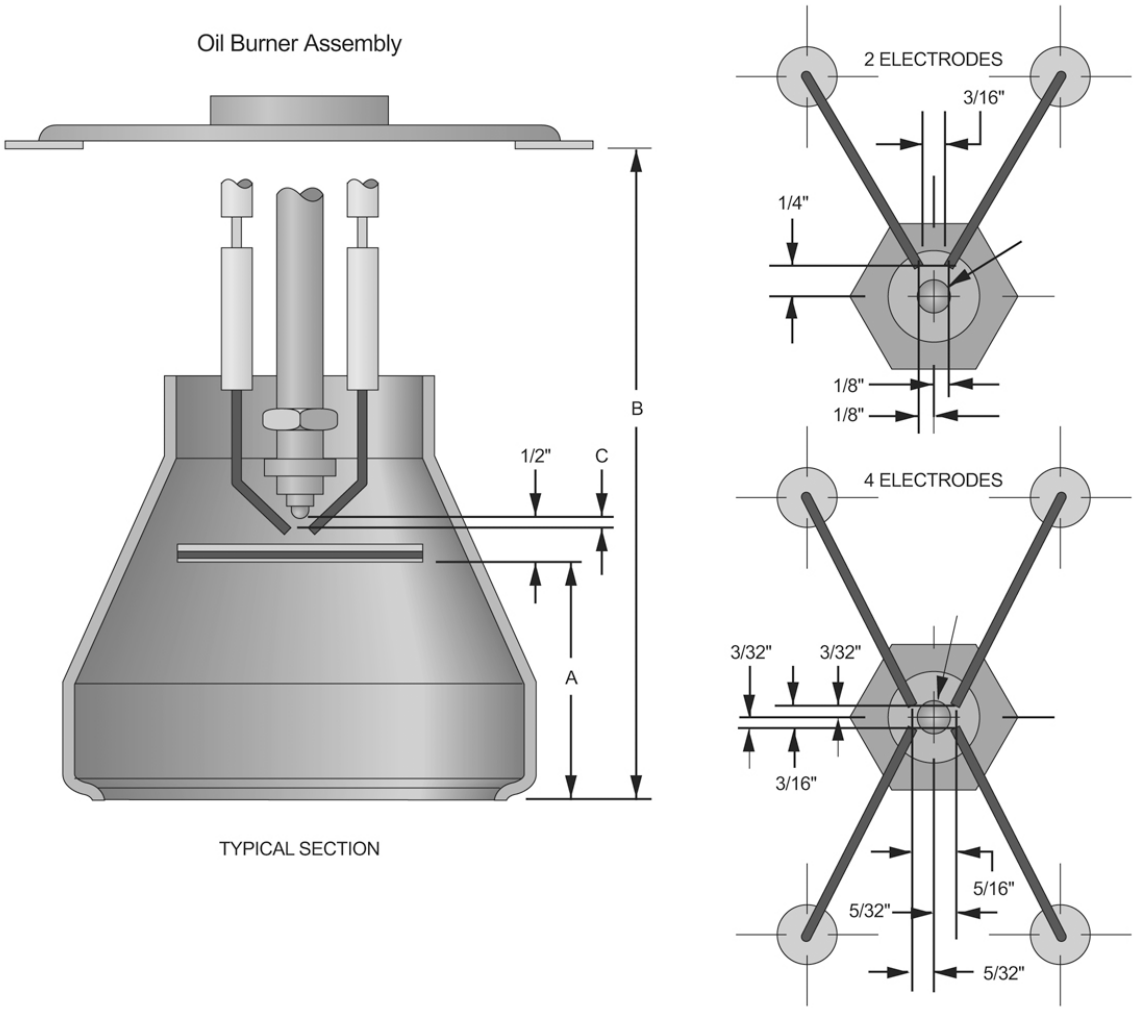
f) Check coil for soot buildup. Clean if necessary

Annually

a) Replace ignition electrode.
b) Clean all the strainers in the thermal fluid system.
c) Take a quart sample of thermal fluid and have it analyzed per fluid manufacturers instructions.
d) Schedule the local representative or factory technician to perform preventative maintenance on the system.

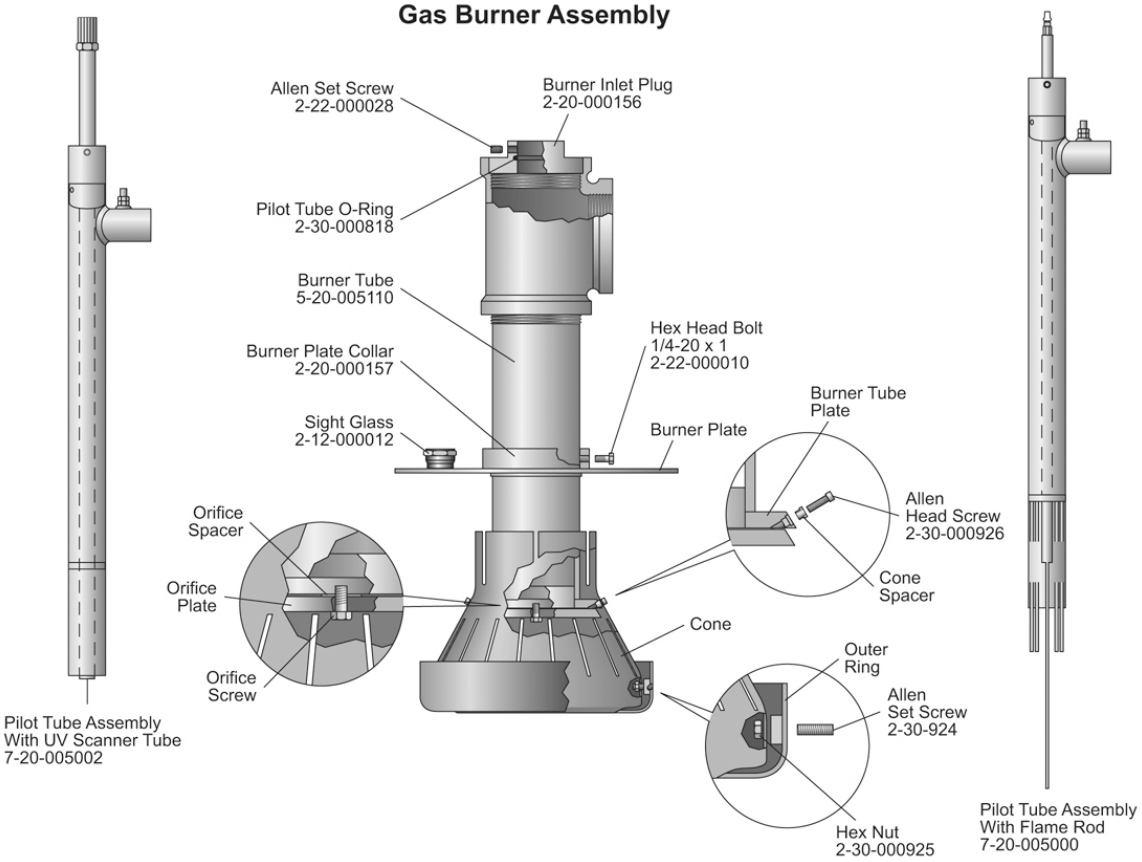
Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.



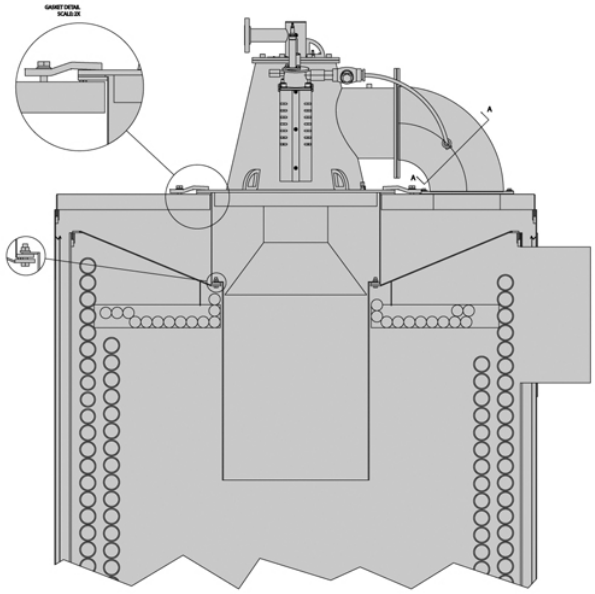
Model FT	0080 w/6 1/8" Cone	0080 w/6 1/8" Cone	01201 0160	0240	0320	0400
A	2 ¾ "	3 ¾"	3 15/16"	3 11/16"	3 5/8"	3 9/16"
B	*	*	11 9/16"	14 ¼ "	15 ½"	17 11/16"
C	¼"	¼"	¼"	¼"	¼"	¼"

Gas Burner Assembly

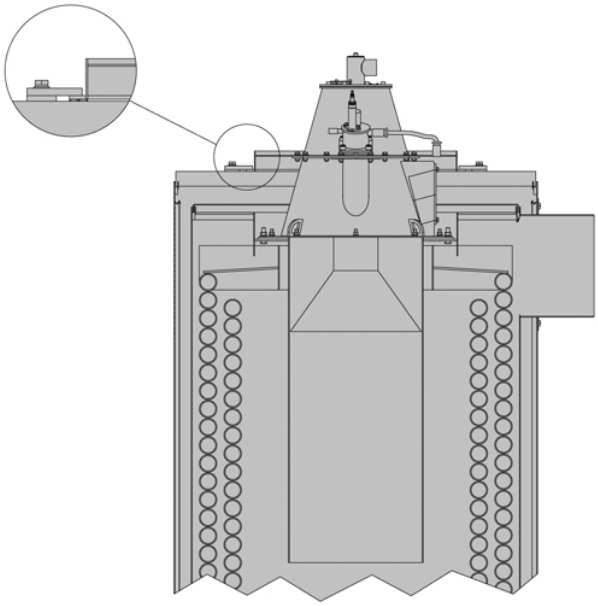


Model FT	**0080**	**0120**	**0160**	**0240**	**0320**	**0400**
Outer Ring	2-30-910	2-30-910	2-30-910	2-30-911	2-30-911	2-30-912
Cone w/ Outer Ring	2-30-909	2-30-664	2-30-664	2-30-665	2-30-670	2-30-666
Cone Spacer	2-20-185	2-20-184	2-20-184	2-20-184	2-20-184	2-20-183
Allen Head Screw	2-30-928	2-30-928	2-30-928	2-30-928	2-30-928	2-30-928
Orifice Plate	2-20-173	2-20-173	2-20-173	2-20-172	2-20-172	2-20-171
Orifice Spacer	2-20-178	2-20-177	2-20-176	2-20-175	2-20-175	2-20-174
Orifice Screw	2-30-918	2-30-918	2-30-918	2-30-918	2-30-918	2-30-817
Burner Tube Assembly	7-30-5000	7-30-5000	7-30-5000	7-30-5002	7-30-5002	7-30-5004
Burner Plate Assembly	5-52-4000	5-52-4000	5-52-4000	5-52-4004	5-52-4004	5-52-4006
Complete Burner Less Pilot	7-30-4000	7-30-4001	7-30-4002	7-30-4004	7-30-4005	7-30-4006

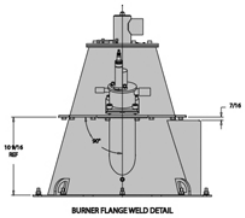
Burners Used for LE Heaters



Maxon Optima Burner
FT800-C through FT1400-C



Maxon MPakt Burner
FT320-C through FT600-C



6. Troubleshooting

Flow Circuit/Circulating Pump(s)

a) The flow circuit is the electrical circuit that enables the circulating pump(s). Your thermal fluid pump(s) will remain on until the flow circuit opens to disable the pump starter or the Off / Pump / Heat switch is turned to the "Off" position.

b) Items in the flow circuit may include paddle type flow switches, a high inlet pressure switch, a low inlet pressure switch, a high outlet pressure switch and a differential pressure switch.

c) Low Inlet Pressure Switch

1. All C-Model heaters have a Low Inlet Pressure Switch. This is a normally open switch that closes with proper heater inlet pressure. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap of the mercury bulb in a "made" condition.
2. The purpose of the Low Inlet Pressure Switch is primarily to protect the heater from a low flow condition. The Low Inlet Pressure Switch should be set at 5 psi below normal heater inlet pressure as read at operating temperature assuming that none of the conditions mentioned below are true. A tripped Low Inlet Pressure Switch is an indication of one of the following.
3. If your Low Inlet Pressure Switch is not making, check the following items:

d) *Plugged circulation pump strainer basket*

1. A plugged strainer will result in a decrease of flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is between 0 and -5" Hg.
3. If the strainer is plugged, isolate the strainer and drain that section of piping being mindful of the temperature of the thermal fluid.
4. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new pump suction pressure.

e) Failed circulation pump coupling

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor.
2. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it is recommended to re-align the circulating pump first at ambient temperature and again when it's at operating temperature. Alignment should be within pump manufacturers' specifications.

f) Cavitation of the circulating pump

1. Cavitation occurs when a pump experiences a loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the combination tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup or anytime new piping or fluid is added to the thermal oil system.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from possible heat exchanger failure.

g) System is Open

1. Lack of back-pressure. If control valving is improper or pressure drop across the system is too low, the resulting minimal back-pressure may not provide enough resistance for the flow to make the pressure switch. Check the thermal fluid system for proper operation of control valves.

h) Blocked sensing line on pressure switch

1. A blocked sensing line will give an inaccurate pressure reading to the pressure switch. A blocked line will need to be replaced or cleaned. Most installations have block valves at the heater to facilitate safe isolation and cleaning of the sensing line.

i) Improper switch setting

1. The Low Inlet Pressure Switch should be set at 5 psi less than the pressure read on the heater inlet pressure gauge at full operating temperature of the system.

j) Faulty Switch

1. If pressure is verified and reads correctly above set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

k) High Outlet Pressure Switch

1. All C-Model heaters have a High Outlet Pressure Switch. This is a normally closed switch that opens with excessive heater outlet pressure.
2. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition.
3. The purpose of the High Outlet Pressure Switch is primarily to protect the heater from building too much pressure. Typical coil model heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold.
4. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.
5. A tripped High Outlet Pressure Switch is an indication of one of the following and will require the manual reset button on the switch to be pushed:

l) An obstruction downstream of the heater

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass). Bypass regulating valve(s) should be adjusted to equal flow condition through users.
3. Call or e-mail Fulton for further details. It may be possible that an automatic control valve has failed. If this is the case, the valve actuator should be inspected and possibly replaced.

m) Improper switch setting

1. The High Outlet Pressure Switch should be set at 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation at the coldest ambient temperature expected.

n) Faulty Switch

1. If pressure is verified and reads correctly below set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

o) Flow Switches

1. Units older than mid-1993 have Flow Switches on the inlet of each pipe in the coil. These are normally open switches that close, making a micro-switch, upon flow establishment.
2. The purpose of the Flow Switch(es) is to protect the heater coil from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature. Each flow switch is wired in series requiring flow through each pipe in the coil.

Flow Switches Not Making

a) An obstruction downstream of the Flow Switch(es)

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged circulation pump strainer basket

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is -2 psi (5 in. Hg).

3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) *Failed circulation pump coupling*

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) *Cavitation of the circulating pump*

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller.
2. During this time, the pump impeller spins without actually circulating any thermal fluid. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) *Plugged coil pipe(s)*

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

f) *High inlet pressure switch*

1. Units newer than mid-1993 have a High Inlet Pressure Switch. This is a normally closed switch that opens with improper heater inlet pressure.

2. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition. The purpose of the High Inlet Pressure Switch is to protect the heater from building too high of a pressure.
3. Typical coil model heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.

Tripped High Outlet Pressure Switch

a) An obstruction downstream of the heater

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged coil pipe(s)

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

c) Improper switch setting

1. The High Inlet Pressure Switch should be set at ambient temperature. The setting should be 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation.

d) Differential Pressure Switch

1. Units newer than mid-1993 have a Differential Pressure Switch. This is a normally open diaphragm switch that closes with a proper heater differential pressure between the heater inlet and outlet.

2. The purpose of the Differential Pressure Switch is to protect the heater coil from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature. Each heater model number has a specific minimum differential pressure.
3. See Section 1 if you do not know this pressure. This pressure is the difference in pressure between the heater inlet pressure gauge and the heater outlet pressure gauge.

Differential Pressure Switch Break

a) An obstruction downstream of the heater outlet

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged circulation pump strainer basket

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is 5-10 psi (10-20 in. Hg).
3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) Failed circulation pump coupling

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs

to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) *Cavitation of the circulating pump*

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
3. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) *Plugged coil pipe(s)*

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids.
2. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

f) *Improper switch setting*

1. The Differential Pressure Switch should be set at operating temperature. The setting should be 2 psi below the minimum differential pressure for that particular heater model number. If the minimum required pressure is not known, compare model of heater to chart on page 1-x of this manual.

Call For Heat

a) The call for heat circuit is the circuit that enables burner operation. Fulton Thermal Corporation has used a variety of Temperature Controllers to act as the Call for Heat.

b) Generally these controls work in combination with a control relay. When the Temperature Controller calls for heat, a signal is sent to the coil of a control relay that closes a normally open set of contacts in series with the burner circuit.

c) When the call for heat is met, the signal is removed and the contacts return to their open state. Situations that may interfere with the Call for Heat circuit include the following:

1. Programming problem
    a. Fulton has a general program for each of the temperature controllers we have used over the years. Compare your current temperature controller program to Fulton's general program.
    b. See the back of this section for general programming sheets for standard Fulton heaters.
    c. Make changes as necessary. Contact Fulton service department with any questions.
2. Temperature controller failure
    a. If the temperature controller is calling for heat but is not putting power on the output to the control relay, the relay will not close the normally open contacts and the heater will remain disabled. If this is the case, some controllers have separate sets of contacts that may be utilized in replacement of the damaged contacts. Some rewiring and/or reprogramming will be needed. Contact Fulton service department if necessary.
3. Temperature sensor failure
    a. Different temperature controllers use different types of temperature sensors. These may be Type J thermocouples, mercury bulbs, RTDs or another type of sensor. It is possible for these sensors to malfunction. To verify proper sensor operation, use an alternate source of temperature detection such as an infra-red temperature sensor to sense temperature at the same point.
4. Control relay may have failed
    a. Many temperature controllers energize a relay with a call for heat that in turn closes a normally open set of contacts to energize the burner circuit.
    b. If your temperature controller is sending an output signal to the control relay but the burner does is not initiated, check resistance across coil of the relay. An open reading indicates that the relay needs to be replaced. If the coil shows resistance, energize coil and check

contacts. With coil energized, normally open contacts should close resulting in a reading of control voltage on both the common and normally open contact.

c. If voltage exists on common but not on normally open contact either switch contacts if another set of normally open contacts are available or replace relay.

Burner Interlock

a) The burner interlock is the electrical circuit that enables the flame programmer. Your thermal heater needs to have the items in the burner interlock 'made' before ignition can occur. Items in the burner interlock may include an air switch, air filter switch, auxiliary blower motor starter contacts, high temperature limit(s), high gas pressure switch, low gas pressure switch, and / or low oil pressure switch.

b) Air Switch

1. All C-model heaters have an Air Switch. This is a normally open switch that closes with proper burner fan outlet pressure. This switch is generally a diaphragm type switch.
2. The Air Switch is a safety device that proves that there is an adequate pressure and volume of make up air for proper combustion and mixing. There is no manual reset on the air switch itself to indicate a trip. The most likely time of an air switch trip is at low fire purge or low fire. If this switch trips, it is generally one of the following issues.

c) The combustion blower fan is dirty

1. If the cups of the squirrel cage type fan become dirty, less air will be moved by the fan. If the fans are dirty enough, there will not be enough air flow for the air switch to prove. You should assure that the combustion blower fan is clean, reset the flame programmer and try to light unit again.

d) The sensing line is plugged, crimped or pointing in the wrong area

1. If the sensing line to the air switch is crimped or blocked, the switch will not sense the proper pressure. Ensure that the sensing line is clear and not crimped by removing both sides of the sensing line and using compressed air to blow through the line. Also ensure that the elbow acting as an air scoop is pointing directly into the air stream. Reset the flame programmer and try to light the unit again.

e) The switch setting is improper

1. The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the

screw clockwise to increase setting, counter-clockwise to decrease setting. To set switch, run unit at low fire. Increase setting 1/2 turn every 5 seconds until unit trips on interlock. Decrease setting by 2 full turns. Reset unit.

f) Air Filter Switch

1. C-model heaters with an air filter box or ducted supply air have an Air Filter Switch. This is a normally closed switch that opens on too high of a suction pressure at the burner fan inlet. This switch is generally a diaphragm type switch.
2. The Air Filter Switch is a safety device that proves that there is not too negative of a pressure at the combustion blower inlet. This switch is only used on units that have a built in air box for use as a duct connection or air filtering device.
3. There is no manual reset on the air filter switch itself to indicate a trip. The most likely time of an air filter switch trip is at high fire purge or high fire. If this switch trips, it is generally one of the following issues.

g) The air filter is dirty

1. If the air filter becomes dirty, the fan will generate greater suction. Too much suction will result in not enough airflow for proper combustion and mixing and will cause air switch to trip. You should regularly change filters on a schedule dependent on how dirty the makeup air is. After checking or changing air filter, reset the flame programmer and try to light unit again.

h) There is an obstruction in the make-up air ducting

1. Units that have make-up air ducting need to assure that blockage to the ducting does not occur. Check outside termination and any bends in the ducting for blockage. Clear blockage, reset flame programmer and try to light unit again.

i) The sensing line is pointing in the wrong area

1. The sensing line for the air filter switch is supposed to provide the static pressure of the air box. The termination of the sensing line should be pointing in a direction that limits its contact with moving air.
2. If the sensing line is pointing perpendicularly to entering air stream, the switch will not sense the proper pressure and could give a false indication of air box suction. Reset the flame programmer and try to light the unit again.

j) The switch setting is improper

1. The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the screw clockwise to increase setting, counterclockwise to decrease setting. The switch setting should be set in such a way that with 50% of the air box opening blocked, the switch will trip. Reset switch setting, reset the flame programmer and try to light the unit again.

k) Auxiliary Blower Motor Starter

1. All C-model heaters use an auxiliary set of contacts on their blower motor starter to prove that the burner motor is latched on. This is a normally open set of contacts mounted on or built in to the blower motor starter.
2. The Auxiliary Blower Motor Contacts are a safety device that proves that the blower motor starter is latched in. These contacts work in redundancy to the air switch to prove that there is proper makeup air. There is no manual reset on the auxiliary contacts themselves to indicate a trip. If the contacts do not make, it is generally one of the following issues.

l) The blower motor starter coil is bad

1. If this is the case, the blower starter will not latch in. Check for voltage to the coil. If proper voltage is present and the starter does not pull in, that proves the coil is bad. Replace the starter, reset the flame programmer and try to light unit again.

m) The auxiliary contacts are burned or pitted

1. Visibly inspect contacts. With power off, attempt to clean or replace starter if damaged. Reset flame programmer and try to light unit again.

n) High temperature limit

1. All thermal fluid heaters have at least one High Temperature Limit. The high temperature limit(s) is/are normally closed switch(es) that break on a temperature rise over set point.
2. The switch may be either a solid state controller or a bulb and capillary type switch. The High Temperature Limit is a safety device that protects the thermal fluid and heat transfer coil from excessively high temperatures.
3. Solid-state high temperature limits will have a manual reset. Bulb and capillary type limits will not have a manual reset. If this/these switch(es) trips, it is generally one of the following issues.

o) Flow rate is too low

1. Too low of a flow rate will result in a higher rate of heat transfer to the thermal fluid and heat transfer coils. This will result in a higher temperature difference between inlet temperature and outlet temperature.
2. It is important to make sure that the minimum flow rate as specified by Fulton for that specific model is maintained.
3. Check inlet and outlet pressures of the heater to determine differential pressure and flow rate. Ensure that this flow rate meets or exceeds minimums specified by Fulton (see chart). Also check differential pressure switch for proper operation and setting.

p) The heater is over-fired

1. If the heater has more fuel input than design, it is probable that the heat transfer rate will increase beyond design.
   Check input to heater at high fire for modulated heaters or at the standard rate for on / off units. This can be done by either using a corrected gas meter reading or measuring gas pressure supplied to the burner compared to factory test-fire settings.
2. If input is improper, inspect burner as described below. If burner is not damaged or have improper components, adjust fuel input and combustion to specification.

q) Gas-fired burner is damaged

1. Pull and inspect the burner. Primary areas of concern for gas-fired units are the orifice plate, pilot assembly seating and orifice plate gap.
2. If the orifice plate is warped or burned through, pilot assembly is not seated or gap between orifice plate and gas tube is improper, more fuel than designed for will enter the furnace.
3. This will cuase the heater to have more fuel input than designed for. The design flow rate will then be too low causing the fluid to heat up higher than it should.

r) High Gas Pressure Switch

1. All gas-fired modulating or IRI rated thermal fluid heaters have a High Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure increase over set point.
2. The High Gas Pressure Switch is a safety device that protects the burner from receiving too high of a gas pressure. The switch

senses this pressure downstream of the last gas valve, upstream of the modulation valve on units that modulate.

3. This switch is most likely to trip at low fire. If this switch trips, it is generally one of the following issues.

s) Gas pressure setting on the main regulator is too high

1. With unit running at high fire, make sure that the modulated gas valve is at full open.

Note

Since unit lights at low fire, it may be necessary to increase high gas pressure setting or jumper contacts to allow unit to modulate to where modulation gas valve back pressure is lessened.

2. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus p urge pressure. Make sure net pressure reading is within .2" w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.

t) Low fire gas valve setting is too low

1. Because the sensing point of the High Gas Pressure Switch is upstream of the modulating gas valve, the highest pressure read will occur during low fire.
2. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .1" w.c. of factory reading. If there is a difference, adjust modulating gas valve linkage. Adjust for proper combustion throughout range.

u) Gas orifice plate is warped

1. If above two items are proper, check the pressure that the high gas pressure switch is sensing by way of a tee installed in the line. Hold unit at low fire and check pressure. Setting on switch should be 10% over pressure read. Call Fulton if you have any questions.

v) Gas pressure switch setting is improper

1. If above two items are proper, check the pressure that the high gas pressure switch is sensing by way of a tee installed in the line. Hold unit at low fire and check pressure. Setting on switch should be 10% over pressure read. Call Fulton if you have any questions.

w) Gas regulator has failed open

1. This is highly unlikely. Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. Make sure that the downstream pressure does not exceed the range of the spring. If regulator has failed, replace, reset input and adjust input throughout the range.

x) Low Gas Pressure Switch

1. All gas-fired modulating or IRI rated thermal fluid heaters have a Low Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point.
2. The Low Gas Pressure Switch is a safety device that protects the burner from receiving too low of a gas pressure. The switch senses this pressure just downstream of the gas regulator. This switch will most likely trip at high fire. If this switch trips, it is generally one of the following issues.

y) Gas pressure setting on the main regulator is too low

1. At high fire, the modulating gas valve is full open resulting in the least amount of back pressure in the gas train. With unit running at high fire, check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .2" w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.

z) Gas orifice plate is damaged

1. If the orifice plate is damaged, it may be holding back less gas creating a lower pressure on the sensing switch. Pull burner and inspect gas orifice plate. Plate should in no way be warped or degraded. If it is, replace. After reinstallation, recheck input and adjust combustion throughout range.

aa) Gas pressure switch setting is improper

1. If above two items are proper, check the pressure that the low gas pressure switch is sensing by way of a tee installed in the line. Hold unit at high fire and check pressure. Setting on switch should be 10% under pressure read. Call Fulton if you have any questions.

bb) Gas regulator has failed closed

1. Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. If regulator has failed, replace, reset input and adjust input throughout the range.

cc) Low oil pressure switch

1. All oil fired modulating thermal fluid heaters have a Low Oil Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point. The Low Oil Pressure Switch is a safety device that protects the burner from receiving too low of an oil pressure. The switch senses this pressure just downstream of the gas pump. If this switch trips, it is generally one of the following issues.

dd) Oil pressure setting on the back pressure valve is too low

1. At low fire, the modulating oil valve is at its most open position resulting in the least amount of back pressure in the fuel train. With unit running at low fire, check oil pressure and compare to factory test fire sheet. Make sure oil pressure reading is within 10 psi of factory reading. If there is a difference, adjust back pressure regulator. Adjust for proper combustion throughout range.

ee) Fuel oil pump may have lost its prime

1. An air bubble in the pump will result in a momentary loss of prime that will be enough to cause the Low Oil Pressure Switch to trip. Ensure that oil pump is primed properly and all connections are tight. Check the pump seal. A blown seal will allow air in the pump housing.

ff) Fuel oil pump motor may have failed

1. Check the pump motor for proper voltage. If voltage is proper but motor does not turn, replace or rebuild motor. If there is no voltage, check motor starter for input signal and incoming 3-phase power.

gg) Fuel oil pump coupling may have failed

1. A failed coupling will result in the pump not turning. Check coupling. Replace if necessary.

Pilot Flame Failure

a) A Pilot Flame Failure is a flame failure that occurs when the unit is trying to establish an adequate flame signal. Solid-state controllers indicate a Pilot Flame Failure by showing as a fault code either Fault 28 for Honeywell 7800 series controllers.

b) Flame Failure PTFI on Fireye E110 series controllers or Fault 9 on Fireye Nexus controls.

c) For electro-mechanical controls, you need to witness when the failure occurs.

d) A Pilot Flame Failure indicates that either a strong enough pilot flame was not generated or the means of sensing the pilot flame strength has failed. All gas fired units have a gas pilot. Oil fired units may be 2-stage, in which the 1st stage to light would be considered the pilot, or may have a gas pilot. In either case, during the pilot proving period, the flame programmer must sense a strong enough flame to initiate the opening of the main valves.

e) Pilot flame strength is inadequate

1. Cycle the unit. During the pilot trial for ignition, carefully observe the pilot flame strength.
2. On Honeywell controllers, the pilot flame strength must be between 1.25 to 5.0 VDC. On Fireye controllers, the pilot flame strength must be greater than 10 VDC.
3. Current controls are supplied with a test switch that can hold the programmer in the pilot trial for ignition stage. If a pilot signal greater that 0.0 but less than the minimum required is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame. If flame is seen, make small adjustments to increase pilot gas and air to provide larger flame.

f) Pilot sensing device does not work properly

1. Cycle the unit. If a pilot signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame.
2. If flame is seen, your flame detection device or amplifier may be faulty. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows isgns of heat impingement, has been burdned off or has cracks in the porcelain, replace with a new flame rod.
3. Reinstall and cycle unit. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube. Make sure that the lens of the scanner is clean. Use a

lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unti does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.

g) Room air pressure is different from outside air pressure

1. Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.

Main Flame Failure

a) Main Flame Failure is a flame failure that occurs while the unit is trying to establish an adequate flame signal during the Main Flame Trial for Ignition.

b) Solid state controllers indicate a Main Flame Failure by showing as a fault code of either Fault 19 for Honeywell 7800 series controllers, Flame Failure MTFI on Fireye E110 series controllers, or a Fault 09 for Fireye Nexus controls. For electro-mechanical controls, you need to witness when the failure occurs.

c) A Main Flame Failure indicates that either a strong enough main flame was not generated or the means of sensing the main flame strength has failed. During the main flame proving period, the flame programmer must sense a strong enough flame to hold the main valves open. If you are experiencing Main Flame Failures, check the following items.

d) Main flame strength is inadequate

1. Cycle the unit. During the main flame proving period , carefully observe the pilot flame strength. Current controls are supplied with a test switch that can hold the programmer in the main flame proving period.
2. If a main signal is greater than 0.0 but less than the minimum required is detected, look through the observation port to try to visibly see flame. A combustion change may be necessary to establish main.
3. If observed flame is blue, slightly decrease the air damper setting and recycle. If flame is red or orange, slightly increase air damper setting and recycle. Once adequate flame signal is established, reset input and combustion throughout range of modulation.

e) Flame sensing device does not work properly

1. Cycle the unit. If a signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to

visibly detect flame. If flame is seen, your flame detection device or amplifier may be faulty.

2. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows signs of heat impingement, has been burned off or has cracks in the porcelain, replace with a new flame rod. Reinstall and cycle unit.
3. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube Make sure that the lens of the scanner is clean. Use a lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unit does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.

f) Room air pressure is different from outside air pressure

1. Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.

g) Unit is experiencing too great of a restriction

1. At the breaching of the heater, take a draft reading. Draft should read between -.02" w.c. and -.04" w.c. with the heater off and between -.04" w.c. and -.08" w.c. with the unit on. A restrictive draft would be a draft that was positive. A restrictive draft is usually the result a stack that is undersized, a stack with too many elbows or a stack whose cap or piping is warped and damaged. Another source of restriction results from broken refractory. If the unit's refractory breaks, large enough pieces could block the flue passes. The burner should be pulled for refractory inspection. A broken refractory should be cleaned out and replaced.

7. Fulton Thermal Fluid Heater Log Sheet

Fulton Thermal Fluid Heater Log Sheet

Date	Time	Pump Status	Heater Status	Heater Inlet Pressure	Heater Outlet Pressure	Differential Pressure	Pump Suction Pressure	Setpoint Temperature	Current Temperature	Nitrogen Level	Pilot Flame Signal	Run Flame Signal	Stack Temperature
Date	*Time*	*On or Off*	*On or Off*	*psi*	*psi*	*or greater*	*psi*	*F*	*F*	*psi*			

Section 5

Section 5 – Parts & Warranty

Part Number	Description	Approx. lbs.	Weight kgs.	Lead Time
Air Filter Box (filters and air filter switch required)				
5-21-006625	Air Filter Box-0080C (1-20”x 20” filter required			Stock
5-21-006617	Air Filter Box	45.6	20.8	Stock
5-21-006600	Air Filter Box			Stock
5-21-006620	Air Filter Box			1 Week
2-30-000620	Air Filter-20”x20”x2”	4.1	1.9	Stock
2-30-000621	Air Filter-24"x24”x2”	5.1	2.3	Stock
Barometric Dampers				
2-30-000097	10” M&MG2 Barometric Control	8.0	3.64	1-2 days
2-30-000098	12” M&MG2 Barometric Control	12.0	5.45	1-2 days
2-30-000099	14” M&MG2 Barometric Control	16.0	7.27	1-2 days
2-30-003010	18” M&MG2 Barometric Control	31.0	14.0	1-2 days
2-30-003011	24” M&MG2 Barometric Control	66.0	60.0	
2-30-003012	28” M&MG2 Barometric Control	93.0	42.2	1-2 days
BURNERS				
Gas Burners				
7-30-004000	Complete FT-0080-C Gas Burner Less Pilot Tube	28.5	12.95	Stock
7-30-004001	Complete FT-0120-C Gas Burner Less Pilot Tube	28.68	13.04	Stock
7-30-004002	Complete FT-0160-C Gas Burner Less Pilot Tube	28.88	13.13	Stock
7-30-004004	Complete FT-0240-C Gas Burner Less Pilot Tube	42.8	19.45	Stock
7-30-004005	Complete FT-0320-C Gas Burner Less Pilot Tube	42.8	19.45	Stock
7-30-004006	Complete FT-0400-C Gas Burner Less Pilot Tube	46.52	21.15	Stock
7-30-004008	Complete FT-0600-C Gas Burner Less Pilot Tube	205.0	93..2	Stock
7-30-004010	Complete FT-0800-C Gas Burner Less Pilot Tube	155.0	70.5	Stock
Gas Burner Parts				
2-20-000054	UL Style Electrode	0.36	0.16	Stock
2-20-000071	UL Style Flame Rod	0.4	0.18	Stock
2-45-000025	Electrode Terminal-Female 90°			Stock
2-45-000392	Flame Rod Terminal-Male 90°			Stock
2-45-000026	Bakelite Terminal-Female Straight			Stock
7-20-005000	Pilot Tube w/Flame Rod	3.96	1.8	Stock
7-20-005002	Pilot Tube for U.V.-new style-3/01	3.94	1.79	Stock
7-20-005004	Inner Pilot Assembly w/ UV-new style-3/01	1.86	0.85	Stock
7-20-005020	Inner Pilot Assembly w/Flame Rod	1.86	0.85	Stock
7-20-005030	UV sight Tube only-new style-3/01	1.0	0.45	Stock
5-20-000810	Ground fins-for Flame Rod (6 required)			Stock
7-20-005010	Pilot Casing Assembly			Stock

1" Sight Glass				
2-11-000107	Peep Hole Casting	0.15	0.06	Stock
2-12-000014	1" Pyrex Disc	0.02	0.01	Stock
2-12-000015	Peep Hole Gasket	0.03	0.01	Stock
¾" Sight Glass				
2-12-000012	Flame Sight Glass	0.05	0.01	Stock
2-30-000568	1"Air Hose			Stock
2-30-000569	1" clamp			Stock
2-30-000924	Ring Screw	0.0	0.0	Stock
2-30-000925	Ring Nut	0.0	0.0	Stock
2-30-000910	FT-0080/0120/0160-C Outer Ring	1.76	0.8	Stock
2-30-000911	FT-0240/0320-C Outer Ring	2.72	1.24	Stock
2-30-000912	FT-0400-C Outer Ring	4.6	2.09	Stock
Miscpart	FT-0600-C Outer Ring	7.0	3.18	
2-30-000926	Cone Screw-4 required 0080-0320C/8 required 400C and up	0.0	0.0	Stock
2-20-000185	Cone Spacer .035 for FT-0080-C – 4 required	0.0	0.0	Stock
2-20-000184	Cone Spacer .079 for FT-0120/0160/0240/0320-C-4 required	0.0	0.0	Stock
2-20-000183	Cone Spacer .114 for FT-0400-C – 8 required	0.0	0.0	Stock
2-20-000182	Cone Spacer .121 for FT-0600-0800-C – 8 required	0.0	0.0	Stock
2-30-000909	Flame Cone FT-0080-C w/ ring*	2.88	1.31	Stock
2-30-000664	Flame Cone FT-0120-C & FT-0160-C w/ring*	5.22	2.37	Stock
2-30-000665	Flame Cone FT-0240-C w/ring*	4.88	2.22	Stock
2-30-000666	Flame Cone FT-0400-C w/ring*	10.52	4.78	Stock
2-30-000667	Flame Cone FT-0600-C w/ring*	13.38	6.08	Stock
2-30-000668	Flame Cone FT-0800-C w/ring*	28.3	12.9	Stock
2-30-000670	Flame Cone FT-0320-C w/ring*	4.88	2.22	Stock
5-21-006518	Refractory Spider-0080-0160C	15.0	6.0	Stock
5-21-006519	Refractory Spider-0240C	20.0	8.0	Stock
5-21-006498	Refractory Spider-0320C	20.0	8.0	Stock
5-21-006499	Refractory Spider-0400C	15.0	6.0	Stock
Miscpart	Plywood form for top Refractory	12.0	4.8	Stock
5-10-000494	FT-0600C Gas Burner Tile	205.0	93.2	Stock
5-10-000492	FT-0800C Gas Burner Tile	120.0	54.6	Stock
2-20-000186	Orifice Spacer .035 FT-0080-C Nat Gas (3 total)	0.02	0.01	Stock
2-20-000177	Orifice Spacer .052 FT-0120-C Nat Gas (3 total)	0.02	0.01	Stock
2-20-000176	Orifice Spacer .0158 FT-0160-C Nat Gas (3 total)	0.04	0.02	Stock
2-20-000175	Orifice Spacer .0140 FT-0240/0320-C Nat Gas (3 total)	0.06	0.03	Stock
2-20-000174	Orifice Spacer .0200 FT-0400/0600-C Nat Gas (6 total)	0.06	0.03	Stock
2-20-000216	Orifice Spacer .0235 FT-0800-C Nat Gas (6 total)	0.06	0.03	Stock
2-30-000918	Orifice Screw FT-0080/0120/0160/0240/0320-C (3 total)	0.04	0.02	Stock
2-30-000817	Orifice Screw FT-0400/0600/0800-C (6 total)	0.04	0.02	Stock
2-20-000173	Orifice Plate FT-0080/0120/0160-C **	1.84	0.84	Stock

2-20-000172	Orifice Plate FT-0240/0320-C**	3.94	1.79	Stock
2-20-000171	Orifice Plate FT-0400-C**	5.14	2.34	Stock
2-20-000170	Orifice Plate FT-0600-C**	7.4	3.36	Stock
2-20-000217	Orifice Plate FT-0800-C**	26.52	12.05	Stock
5-52-004000	FT- 0080/0120/0160 -C Burner Plate	5.34	2.43	Stock
5-52-004004	FT-0240/0320/0400 -C Burner Plate	9.7	4.41	Stock
5-10-002173	FT-0600 -C Burner Plate			Stock
5-10-002175	FT-0800 -C Burner Plate			Stock
7-30-005000	FT- 0080/0120/0160 -C Burner Tube	8.32	3.78	Stock
7-30-005002	FT- 0240/0320 -C Burner Tube	12.02	5.46	Stock
7-30-005004	FT-0400 -C Burner Tube	13.32	6.05	Stock
5-30-004025	FT-0600 -C Burner Tube	14.0	6.37	Stock
5-30-004030	FT-0800 -C Burner Tube	15.0	6.82	Stock
5-30-004020	Burner Inlet Tee	8.44	3.84	Stock
2-30-000818	Burner Tee O-Ring	0.01	0.0	Stock
			***Cone Screws are required with purchase** ****Orifice Screws are required with purchase**	
Oil Burners and Parts				
7-30-004020	FT-0080C/0120C/0160C Oil Burner less nozzle assembly	13.7	6.2	Stock
7-30-004023	FT-0240-C Oil Burner less nozzle assembly	29.4	13.4	Stock
7-30-004024	FT-0400C Oil Burner less nozzle assembly	37.6	17.1	Stock
7-30-004035	FT-0600C Oil Burner less nozzle assembly			Stock
7-30-004038	FT-0800C Oil Burner			Stock
2-20-000258	FT-0080C through FT-0320C Holder Electrode			
2-30-000782	FT-0080/120/0160C Flame Spreader	0.44	0.2	Stock
2-30-000783	FT-0240-C Flame Spreader	0.46	0.21	Stock
2-30-000785	FT-0400/0600-C Flame Spreader	0.2	0.09	Stock
2-30-000786	FT-0800C Flame Spreader	0.9	0.41	Stock
Oil Burner Nozzle Assemblies				
5-30-004275	FT-0080C on/off			1 week
5-30-004270	FT-0080C modulated			1 week
5-30-004276	FT-0120C on/off			1 week
5-30-004271	FT-0120C modulated			1 week
5-30-004277	FT-0160C on/off			1 week
5-30-004272	FT-0160C modulated			1 week
5-30-004273	FT-0320C modulated			
5-30-004278	FT-0400C modulated			
5-30-004274	FT-0240C modulated			1 week
5-30-004279	FT-0600C modulated			
Oil Cones & Assemblies				
2-30-000656	FT-0080C/FT-0120C Flame Cone	3.0	1.36	Stock
2-30-000657	FT-0240C Flame Cone	3.62	1.65	Stock
5-30-000657	FT-0240C Oil Flame Cone with Outer Ring & Refractory			3 days

2-30-000658	FT-0400C Flame Cone	4.38	1.99	Stock
5-30-000658	FT-0400C Oil Flame Cone with Outer Ring & Refractory			3 days
2-30-000659	FT-0600C Flame Cone	6.0	2.73	Stock
5-10-000495	FT-0600C Oil Flame Cone & refractory assembly			1 week
2-30-000660	FT-0800C Flame Cone	10.0	4.55	Stock
2-20-000259	FT-0800C Oil Flame Cone & refractory assembly	.		1 week
2-20-000053	Electrode FT-0080/0120/0160/0240-C	.22	.1	Stock
2-20-000069	Electrode (2.p) FT-0400/0600/0800C (field straighten)	.24	.11	Stock
2-20-000072	Electrode Holder for 2-20-69	.24	.11	Stock
2-20-000259	Electrode Holder for FT-0400/0600C			Stock
Oil Nozzles				
2-30-000671	FT-0080C 5Gal 60 Degree Modulated Nozzle	.04	.02	Stock
2-20-000121	FT-0080C 5Gal 60 Degree on/off Nozzle	.06	.03	Stock
2-30-000688	FT-0120C 8Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000689	FT-0120C 8Gal 60 Degree on/off Nozzle	.04	.02	Stock
2-30-000673	FT-0160C 12Gal 60 Degree Modulated Nozzle	.08	.04	Stock
2-20-000122	FT-0160C 12 Gal 60 Degree on/off Nozzle	.08	.02	Stock
2-30-000674	FT-0240C 17.5Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-20-000120	FT-0240C 17.5Gal 60 Degree on/off Nozzle	.06	.03	Stock
2-20-000200	FT-0320C 19.5Gal 60 Degree Modulated Nozzle			
2-30-000675	FT-0400C 24 Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000153	FT-0400C 35Gal 60 Degree Tip & Disc	.06	.03	Stock
2-30-000676	FT-0600C 30Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000158	FT-0600C 55Gal 60 Degree E180H Tip & Disc	.1	.05	Stock
2-30-000682	FT-0800C 85Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
2-30-000159	FT-1000C 100Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
2-30-000161	FT-1200C 120Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
5-10-003305	Inlet/Outlet Block	.6	.3	Stock
2-30-000600	O'ring for inner oil line			Stock
5-20-004070	Inner oil line	.1	.05	Stock
2-30-G00010	3/8" Check valve			Stock
Dual Fuel Burner Parts				
7-30-004025	Complete FT-0400C Gas burnerless pilot tube-dual fuel/UV Scanner Tube	124.0	56.4	Stock
7-30-004026	Complete FT-0600/0800C Gas burnerless pilot tube-duel fuel/ scanner tube			Stock
7-30-004027	Complete FT-1000/12..C burnerless pilot tube-duel fuel/ scanner tube			Stock
5-20-005499	Air adjustment ring 0400-0800C dual fuel	.9	.4	Stock
5-20-005502	FT-1000C/FT-1200C Flame Cone			Stock
5-20-005508	Oil delivery tube assy – 0400-1200C- dual fuel	7.5	3.4	Stock
5-20-005523	Nozzle adapter-used on 5-20-5508			Stock

5-20-005524	End cap-used on 5-20-5508			Stock
5-21-005506	Gas supply tube assy 0400-0800C	31.5	14.4	Stock
2-20-000087	Orifice retaining collar-0400-0800C	1.7	.8	Stock
5-20-003497	Flame Cone 0400C	13.3	6.1	Stock
5-20-005498	Dual flame cone 0600C			Stock
5-20-005495	Dual flame cone 0800C			Stock
5-20-005547	Gas orifice nozzle assy – 0400-0800C	3.5	1.6	Stock
7-20-005526	Oil/air mixing Nozzle weldment 0400-0800C	.5	.3	Stock
7-20-004015	Dual fuel pilot assy 0400-1400C	3.0	1.2	Stock
5-20-005535	Outer tube assy 0400-1400C-dual fuel	1.0	.46	Stock
5-20-005537	Inner tube assy 0400-1400C-dual fuel	1.0	.46	Stock
5-20-005540	Insulator	.05		Stock
5-20-005541	Insulator	.05		Stock
5-20-005538	Electrode cap			Stock
Miscpart	Rod for electrode cap connector	.02	.2	Stock
2-12-000251	FT-0600C/0800C refractory	210.0	95.5	Stock
2-12-000250	Refractory FT-1000C/1200C			Stock
7-20-005045	Scanner tube 0400-1400C			Stock
5-20-005503	Sleeve 0400-1400C			Stock
2-45-000390	Electrode nut 0400-1400C			Stock
5-21-003000	Screen LoNox			Stock
FANS / BLOWERS / AIR GATE ASSEMBLY **Blowers**				
2-40-000707	1-1/2hp blower motor TEFC 208/480/60/3ph	50.0	22.0	Stock
2-40-000599	3hp blower motor TEFC 208/480/60/3ph	55.0	25.0	Stock
2-40-000622	5hp blower motor TEFC 208/480/60/3ph			
2-40-00079	7 1/2hp blower motor TEFC 208/480/60/3ph	80.0	37.0	Stock
2-40-000870	10hp blower motor TEFC 208/480/60/3ph	168.0	76.3	Stock
2-40-000865	15hp blower motor TEFC 208/480/60/3ph	200.0	91.0	Stock
2-40-000840	20hp blower motor TEFC 208/480/60/3ph	316.0	144.0	Stock
Fans/Air Gate parts				
2-30-000573	8-3/8 x 2-1/2 x 1-1/8 FT-0080/0120C	2.92	1.33	Stock
2-30-000561	9-3/16 x 3 x 1-1/8 FT-0160C	4.66	2.12	Stock
2-30-000562	9-15/16 x 3 x 1-1/8 FT-0160C & 0240C	5.14	2.34	Stock
2-30-000419	10-5/8 x 4 x 1-3/8 FT-0400C Dual Fuel	5.14	2.34	Stock
2-30-000443	12-3/16 x 6 x 1-5/8			Stock
2-30-000563	10-5/8 x 4 x 1-1/8 FT-0240/0320/0400C	6.4	2.91	Stock
2-30-000564	10-5/8 x 1-1/8 FT-0600C	7.4	3.36	Stock
2-30-000444	10-5/8 x 1-3/8 FT-0600C	6.2	2.82	Stock
2-30-000571	12-3/16 x 6 x 1-3/8 FT-0800C & FT-0600C dual fuel	1.72	.78	Stock
2-30-001320	13-15/16 x 6-1/2 x 1-5/8 FT-1000/1200/1400C 0800C dual fuel	17.9	8.14	Stock

2-30-000560	9-3/16 x 2-1/2 x 1-1/8	4.4	2.0	Stock
2-20-000050	5/8 x 1-1/8 shaft adaptor	0.56	.25	Stock
5-10-001850	7/8 x 1-1/8 575v shaft adaptor			Stock
2-30-000483	10-5/8 Mod air control-0080C/Air gate	4.0	1.8	Stock
2-30-000484	12-3/16 Mod air control 0120-0600C/Air gate	5.12	2.32	Stock
2-30-000485	15 Mod air control 800-1400C/Air gate	7.06	3.2	Stock
5-10-001792	Air pick up MTG plate FT-0080C	4.8	2.2	Stock
5-10-001702	Air pick up MTG plate FT-0120C-0600C	6.7	3.1	Stock
5-10-001802	Air pick up MTG plate FT-0800C	5.5	2.5	Stock
7-21-000030	Air gate assy FT 1000-1400C	18.2	8.3	Stock
2-21-000110	Motor mounting plate FT-0120-0160-0240C	4.0	1.6	Stock
2-21-000113	Motor mounting plate FT-0320C	4.0	1.6	Stock
2-21-000111	Motor mounting plate FT-0400-0600C	4.0	1.6	Stock
CONTROLS **Differential/Flow switches**				
2-30-000454	UE H105K14727 differential pressure switch	4.0	1.82	Stock
2-30-000448	UE H105K456 differential pressure switch 2-20 psi	4.0	1.82	Stock
2-30-000453	¼" needle valve (block valve)	1.0	.46	Stock
2-35-000330	Swedgelock-straight	.025		Stock
2-35-000329	Swedgelock-90 degree	.025		Stock
2-35-000526	Steel tubing union			
2-10-000211	¼ OD steel tubing			
2-30-000813	Flow switch O'ring – shaft	.001	0.0	Stock
2-30-000814	Flow switch O'ring – casing	.001	0.0	Stock
Fireye Flame Programmer Controls & Accessories				
2-40-000542	EP380 on/off Module			Stock
2-40-000545	E110 Burner control	5.1	2.32	Stock
2-40-000528	E120 Burner control(220v)	5.6	2.55	Stock
2-40-000543	ED510 Display Module-E120&E110	.5		Stock
2-40-000806	EP170 Programmer	.6	.27	Stock
2-40-000540	EUV-1 UV amplifier	.6	.27	Stock
2-40-000532	UV-1A6 UV scanner	.8	.36	Stock
2-40-000531	Base for control 60-1466-2	.5	.23	Stock
2-40-000897	ED550/6 Cable	.01	0	Stock
2-40-000808	Remote mounting kit	.5	.3	Stock
2-40-000804	ERT-1 rect. Flame rod amp			
2-40-000544	PPC 5000 control			
Honeywell Flame Programmer Controls & Accessories				
2-40-000262	RM7800M1037 Programmer	2.5	1.14	Stock
2-40-000264	RM7800L1038 Programmer	2.5	1.14	Stock
2-40-000260	RM7895A1030 Programmer			
2-40-000265	ST7800A1013 7 Sec.			Stock

2-40-000266	ST7800A1039 30 Sec.	.1	.05	Stock
2-40-000268	ST7849A1041 RM7800 amplifier – flame rod	.3	.14	Stock
2-40-000269	ST7849A1031 RM7800 amplifier –UV amp-80-400C	.2	.09	Consult fact.
Miscpart	Fuel air control R7999A1005			Stock
2-40-000273	ST7800A1098 RM7800 amplifier – UV amp 600-1200C	.2	.09	Stock
2-40-000270	Base for RM7800	.5	.23	Stock
2-40-000272	Display module S7800A1019	.5	.23	Stock
2-40-000161	Mini peeper C7027a1049 UV scanner	.5	.23	Stock
2-40-000149	BC7000L Burner control			Stock
2-40-000860	PM720L1030 Program Module	.06	.03	Stock
2-40-000157	Programmer R4140M-1210	5.0	2.27	Stock
2-40-000711	Programmer R4140L-1162	5.0	2.27	Stock
2-40-000713	Flame rod amplifer R7247A-1005	.12	.05	Stock
2-40-000160	UV amplifier R7249a1003	.1	.05	Stock
2-40-000159	Q520A Base	.5	.23	Stock
2-40-000248	Remote mounting cable	.5	.23	Stock
2-40-000247	Remote display mounting bracket			Stock
Pressure Switches & Transducers				
2-40-003040	Danfos pressure switch w/manual reset 150psi			
2-40-003041	Danfos pressure switch w/auto reset 6-50psi			
2-40-000662	6NN54FIA SOR pressuretrol – NEMA 4	1.62	.73	Stock
2-40-000661	6R3-D5 SOR pressuretrol M/R – NEMA 4	2.1	.95	Stock
2-40-000999	Pressure transducer 0-100psi			Stock
2-40-000994	Pressure transducer 0-200psi			Stock
2-40-000998	Pressure transducer 0-15psi			Stock
Stack Limit Switches				
2-40-000688	1000 deg. F stack limit	1.96	.89	Stock
2-40-000697	1100 deg. F stack limit	1.16	.53	Stock
2-40-000731	1000 deg. F stack limit – NEMA 4	1.38	.63	Stock
2-40-000866	1100 deg. F stack limit – NEMA 4	1.98	.9	Stock
Temperature Controls/Limits/Thermocouples				
2-40-000861	UT 350 yokogawa	1.2	.55	Stock
2-40-000862	UT350L yokogawa	1.16	.55	Stock
2-40-000867	UT 550-04 (RSP) yokogawa	1.16	.55	Stock
2-30-000900	Yokogawa window kit NEMA-4			Stock
2-40-000909	FUJI PYZ4-RAY-1-4V	.5	.23	Stock
2-40-000311	EZ relay			Stock
2-40-000816	UE E54 Temp Limit A,N models	1.66	.75	Stock
2-40-000631	Watlow temp control 146E1602	3.0	1.37	Stock
2-40-000800	2 x 8 Thermocouple wire	.16	.07	Stock
2-40-000801	4 x 12 thermocouple N & A models	.2	.09	Stock
2-40-000802	2 x 12 Thermocouple – C models	.2	.09	Stock

2-40-000805	½" NPT spring loaded thermocouple	.2/FT		Stock
2-40-000830	Thermocouple wire	.1	.1/ft	Stock
2-40-000798	Thermocouple splice kit	.1	.05	Stock
2-40-000799	Thermocouple splice kit		.05	Stock
2-40-001000	6"probe 150-170° F Adj. Thermometer			Stock
Deaerator Tank Parts				
2-30-000551	Liquid level HG34	4.3	1.95	Stock
2-30-000552	NEMA 4 Liquid level HW34	10.32	4.69	Stock
2-30-000553	Explosion proof HR34	10.36	4.71	Stock
2-40-000730	Liquid level switch L4 high & explosion proof	4.22	1.92	Stock
2-30-000554	Magnetrol level switch			
4-30-000200	2-way nitrogen kit (SV not included)			2 weeks
2-30-000138	Fairchild N2 reg #66162-2-150#	2.94	1.34	Stock
2-30-000869	¾" gate valve – fill			
2-30-000214	¾" 15# series 19 V stamped brass safety valve	2	.9	Stock
2-30-000215	1" 15# series 19 V stamped brass safety valve	4.3	1.95	Stock
2-30-000216	1-1/4" 15# series 19 V stamped brass safety valve	6.75	3.1	Stock
2-30-000016	1-1/2"15# series 19 V stamped brass safety valve	12.4	5.63	Stock
2-30-000217	2" 15# series 19 V stamped brass safety valve	14.85	6.75	Stock
Electric Heater Parts "N" Model				
2-40-000910	Main grame for Athena sequencer	2.2	1.0	Stock
2-40-000911	Step card (white)	.1	.05	Stock
2-40-000912	Step delay (yellow)	.1	.05	Stock
2-40-000913	Signal card (green)	.1	.05	Stock
2-40-000914	Starter card (black	.1	.05	Stock
2-40-000105	Honeywell 5-step sequencer	10.2	4.64	Stock
2-40-000107	Honeywell 10-step sequencer	11.	5.0	Stock
2-40-000904	120V/240V 10 step solitec sequencer **Note: Above replaces 5 Step Solitec Sequencer 120V/240V**	1.82	.83	Stock
2-40-000025	600V 60amp contactor – 120V	2.5	1.14	Stock
2-40-000024	300V 60amp contactor – 120V	2.3	1.05	Stock
2-40-000022	600V 60amp contactor – 220V	2.5	1.14	Stock
2-40-000852	21KW 230V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000850	21KW 380V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000847	21WKW 415V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000851	21KW 460V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000848	21KW 575V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000854	11KW 208V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000845	11KW 230V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000846	11KW 380V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000853	11KW 460V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000849	11KW 575V Element NEMA 4 & 7	11	5.0	2-4 weeks

2-12-000068	Element gaskets – 11KW	.04	.01	1 week
2-12-000069	Element gaskets – 21KW	.04	.01	1 week
2-22-000173	2-1/2” element bolt – all thread	.04	.01	Stock
2-35-000348	Nut 5/16”	.04	.01	Stock
2-22-000046	Lockwasher – 5/16”	.03	.01	Stock
FUEL TRAIN COMPONENTS **Manual Gas Valves**				
2-30-000398	¼” mxf brass ball valve			Stock
2-30-000021	1” lube cock	4.86	2.21	Stock
2-30-000022	1-1/4”lube cock	6.5	2.95	Stock
2-30-000013	1-1/2” lube cock	7.0	3.18	Stock
2-30-000012	2” lube cock	10.0	4.55	Stock
2-30-000005	3” lube cock	2.7	1.23	Stock
2-30-000111	½” ball valve	.25	.11	Stock
2-30-000113	1” gas cock	2.0	.91	Stock
2-30-000114	1-1/4” gas cock	3.0	1.36	Stock
2-30-000115	1-1/2” gas cock	4.8	2.18	Stock
2-30-000116	2” gas cock	.08	.36	Stock
Gas Pressure Regulators				
2-30-000102	Maxitrol RV48 ½” (pilot)	.7	.32	Stock
2-30-000104	Maxitrol RV53 1”	1.5	.68	Stock
2-30-000515	Maxitrol RV81 1-1/4”	4.68	2.13	Stock
2-30-000516	Maxitrol RV81 1-1/2”	5.94	2.7	Stock
2-30-000517	Maxitrol RV91 2”	8.28	3.76	Stock
2-30-000518	Maxitrol RV111 3”	16.88	7.67	Stock
2-30-000677	Maxitrol 325-3 – ½” (10 psi)(pilot)	.8	.36	Stock
2-30-000678	Maxitrol210D 1-1/4” (10psi)	5.6	2.55	Stock
2-30-000686	Maxitrol 1-1/2” (10psi)	5.94	2.7	Stock
2-30-000679	Maxitrol 2” (10psi)	10.0	4.55	Stock
2-30-000680	Maxitrol 3” (10psi)	23.44	10.65	Stock
	***14” WC max incoming gas pressure. Consult factory for spring ranges.**			
Safety Shut-off Valves/Actuators				
2-30-000298	½” 8215G20 Pilot Valve	1.64	.75	Stock
2-40-000214	Fluid power actuator V4055V-1031	13.7	6.23	Stock
2-40-000220	Fluid power actuator w/indicator V4055D1043	12.8	5.82	Stock
2-30-000295	Fluid power actuator NEMA 4 V4055D-1027	15.74	7.15	Stock
2-40-000210	Fluid power actuator V4055A1130 – 220V	12.8	5.82	Stock
2-30-000310	1” Honeywell gas valve – V5055A 1004	4.62	2.1	Stock
2-30-000311	1-1/4” Honeywell gas valve – V5055A 1012	4.4	2.0	Stock
2-30-000312	1-12” Honeywell gas valve – V5055A 1020	4.54	2.06	Stock
2-30-000313	2” Honeywell gas valve – V5055A 1038	4.18	1.9	Stock
2-30-000315	2-1/2” Honeywell gas valve – V5055A	4.86		Stock
2-30-000316	3” Honeywell gas valve – V5055A 1053	9.7	4.41	Stock

2-40-000249	1” Honeywell – V5055C 1034	5.0	2.27	Stock
2-40-000252	1-1/4” Honeywell – V5055C1042	5.1	2.32	Stock
2-40-000253	1-1/2” Honeywell – V5055C1059	6.0	3.0	Stock
2-40-000254	2” Honeywell – V5055C1000	9.3	4.23	Stock
2-40-000163	2-1/2” Honeywell – V5055C1018	10.5	4.77	Stock
2-40-000255	3” Honeywell – V5055C1026	11.5	5.23	Stock
Gas Pressure Switches				
2-40-000533	High/Low Gas Pressure Switch 2/16 – 1/6	3.25	1.48	Stock
2-40-000538	High/Low Gas Pressure Switch 5/28 – 2/14	3.16	1.44	Stock
2-40-000539	High/Low Gas Pressure Switch 10/50 – 6/24	3.14	1.43	Stock
2-40-000872	Ashcroft D428B Gas Pressure Switch-Hi	2.8	1.27	Stock
2-40-000871	Ashcroft D429B Gas Pressure Switch-Lo	2.78	1.26	Stock
Vent Valves (used on NFPA85 Fuel Trains)				
2-30-000296	½” Pilot Vent Valve			Stock
2-30-000400	¾” Vent Valve-8215G33	1.8	.81	Stock
2-30-000401	1” Vent Valve-8215C53	3.78	1.71	Stock
2-30-000402	1-1/4” Vent Valve-EF8215C63	5.18	2.35	Stock
2-30-000458	¾” NEMA 4 Vent Valve-EF8215C33	4.58	2.08	Stock
2-30-000447	1” NEMA 4 Vent Valve-EF8215C53	4.6	2.09	Stock
2-30-000446	1-1/4” NEMA 4 Vent Valve-EF8215C63	4.6	2.09	Stock
Butterfly Valves				
2-30-000508	1” Gas Butterfly Valve-Eclipse	2.2	1.0	Stock
2-30-000509	1-1/4” Gas Butterfly Valve-Eclipse	2.3	1.05	Stock
2-30-000510	1-1/2” Gas Butterfly Valve-Eclipse	2.74	1.25	Stock
2-30-000511	2” Gas Butterfly Valve-Eclipse	4.0	1.82	Stock
2-30-000512	3” Gas Butterfly Valve-Eclipse	8.34	3.79	Stock
2-30-000533	24” Pilot Flex Hose	.42	.19	Stock
2-30-000572	18” Pilot Flex Hose	.36	.16	Stock
2-30-000575	24” CGA Flex Hose	.36	.16	Stock
2-30-000570	½” x 36” Flex Hose			Stock
Oil Pumps				
2-30-000127	Oil Pump V023C-40M20	8.34	3.79	Stock
2-30-000212	Oil Pump 18B1H2FX-5B Consult Factory	12.78	5.81	
2-30-000525	Oil Pump 22R2210-5C3	6.82	3.1	Stock
2-30-000526	Oil Pump 22R623C-5C14	8.7	3.95	Stock
2-40-001659	3/4hp TEFC C-Face motor 208/230/460/3ph	20.62	9.37	Stock
5-20-400199	Mounting Bracket-Motor/Pump	4.0	1.82	Stock
Oil Valves				
2-30-000513	N.A. Oil Valve 2-516	9.54	4.34	Stock
2-30-000606	Hauck Oil Valve-S32C	2.02	.90	Stock
2-30-000605	Hauck Oil Valve-S33C	2.46	1.12	Stock
2-30-000514	Hauck Oil Valve-S35C	2.52	1.15	Stock

2-40-000358	Hauck Oil Valve-S39C 400/600C			Stock
2-30-000502	Oil Valve (normally closed) S401AF02V9BFS	1.88	.85	Stock
2-30-000500	Oil Valve 220V	2.0		Consult factory
2-30-000698	Oil Valve-1/4" – 1500PSI-120V	9.2	4.2	Stock
2-30-000685	Oil Pressure Regulator-RV3000	3.04	1.38	Stock
2-30-000497	Maxon Oil Valve W/POC-1/2"	28.0	12.8	Stock
2-30-000G10	Parker Check Valve			
2-30-000780	Oil Pump Coupling L070	.5	.23	Stock
2-30-000033	Coupling Spider L070	.5	.23	Stock
Fuses				
2-45-000368	KTKR2 Amp			Stock
2-45-000366	KTKR4 Amp			Stock
2-45-000367	KTKR5 Amp			Stock
2-45-000365	KTKR8 Amp			Stock
2-45-000380	KTKR10 Amp			Stock
2-45-000465	KTKR12 Amp			Stock
2-45-000655	KTKR15 Amp			Stock
2-45-000464	KTKR20 Amp			Stock
2-45-000268	KTKR25 Amp			Stock
2-45-000249	KTKR30 Amp			Stock
2-45-000152	JKS30 Amp			Stock
2-45-000010	JKS35 Amp			Stock
2-45-000011	JKS40 Amp			Stock
2-45-000012	JKS50 Amp			Stock
2-45-000013	JKS60 Amp			Stock
2-45-000214	LPJ 1-6/10 Amp			Stock
2-45-000151	LPJ2 Amp			Stock
2-45-000360	LPJ3 Amp			Stock
2-45-000361	LPJ4 Amp			Stock
2-45-000250	LPJ5 Amp			Stock
2-45-000363	LPJ7 Amp			Stock
2-45-000267	LPJ10 Amp			Stock
2-45-000266	LPJ15 Amp			Stock
2-45-000265	LPJ20 Amp			Stock
2-45-000278	LPJ25 Amp			Stock
2-45-000264	LPJ30 Amp			Stock
2-45-000263	LPJ35 Amp			Stock
2-45-000262	LPJ40 Amp			Stock
2-45-000261	LPJ50 Amp			Stock
2-45-000260	LPJ60 Amp			Stock
2-45-000382	LPJ70 Amp			Stock

2-45-000343	LPJ80 Amp			Stock
2-45-000374	LPJ100 Amp			Stock
2-45-000270	LPJ125 Amp			Stock
2-45-000271	LPJ150 Amp			Stock
2-45-001000	FNQ2 Amp			Stock
2-45-000381	FNQ3 Amp			Stock
2-45-000998	FNQ4 Amp			Stock
2-45-000995	FNQ5 Amp			Stock
2-45-000272	200 Amp Fuse Block			Stock
2-45-000244	Fuse Block J600-603C			Stock
2-45-000344	Fuse Block J60100-3CR			Stock
2-45-000006	SC-40 Fuse (240V)	.1	.05	Stock
2-45-000007	SC-50 Fuse (240V)	.1	.05	Stock
2-45-000008	SC-60 Fuse (240V)	.1	.05	Stock
2-45-000276	16 Amp Disconnect			Stock
2-45-001050	25 Amp Disconnect			Stock
2-45-001051	40 Amp Disconnect			Stock
2-45-001052	60 Amp Disconnect			Stock
Gaskets & Material				
2-60-000114	Silicone Sealant-red-10 oz	.82	.37	Stock
2-60-000111	Silicone Sealant-clear-10 oz	.82	.37	Stock
2-12-000010	Anti-Seize #76764	1.0	.5	Stock
2-60-000007	Turbo 50-4 oz	.4	.16	Stock
2-12-000052	Graphoil Packaging	.5	.23	Stock
2-12-000060	Kast-o-lite 30 55# per bag (by the pound)	55.0	25.0	Stock
2-12-000210	¼” Rope Gasket			Stock
2-12-000051	3/8” Rope Gasket			Stock
2-12-000003	½” Rope Gasket			Stock
2-12-000049	1” Thermal Bar Gasket-for burner plate			Stock
2-12-000150	Dresser Plate Gasket Material-Omni light			Stock
2-12-000140	Omnilight 8” OD Gasket			Stock
2-12-000141	Omnilight 10” OD Gasket			Stock
2-12-000142	Omnilight 12” OD Gasket			Stock
2-12-000143	Omnilight 4”x9” Gasket			Stock
2-12-000144	Omnilight 4”x14” Gasket			Stock
2-12-000145	Omnilight 6”x12” Gasket			Stock
Elastagraph Ring Gaskets for Flanges				
2-12-000400	½” 150# Gasket	.5	.22	Stock
2-12-000402	¾” 150# Gasket	.8	.44	Stock
2-12-000404	1” 150# Gasket	.1	.05	Stock
2-12-000406	1-1/4” 150# Gasket	.1	.05	Stock
2-12-000408	1-1/2” 150# Gasket	.12	.05	Stock

2-12-000410	2” 150# Gasket	.18	.08	Stock
2-12-000412	2-1/2” 150# Gasket	.22	.1	Stock
2-12-000414	3” 150# Gasket	.14	.06	Stock
2-12-000416	4” 150# Gasket	.32	.15	Stock
2-12-000418	5” 150# Gasket	.4	.18	Stock
2-12-000420	6” 150# Gasket	.42	.19	Stock
2-12-000422	8” 150# Gasket	.45	.2	Stock
2-12-000401	1/2” 300# Gasket	.08	.4	Stock
2-12-000403	3/4” 300# Gasket	.1	.05	Stock
2-12-000405	1” 300# Gasket	.12	.05	Stock
2-12-000407	1-1/4” 300# Gasket	.14	.06	Stock
2-12-000409	1-1/2” 300# Gasket	.18	.08	Stock
2-12-000411	2” 300# Gasket	.18	.08	Stock
2-12-000413	2-1/2” 300# Gasket	.26	.12	Stock
2-12-000415	3” 300# Gasket	.3	.14	Stock
2-12-000417	4” 300# Gasket	.44	.2	Stock
2-12-000419	5” 300# Gasket	.54	.25	Stock
2-12-000421	6” 300# Gasket	.6	.27	Stock
2-12-000423	8” 300# Gasket	.65	.3	Stock
Modulation Parts				
2-40-000722	Modutrol Motor M7284Q-1009 4-20Ma	9.88	4.49	Stock
2-40-000671	Modutrol Motor M9184C-1031 0-135ohm	6.5	2.95	Stock
2-40-000831	Modutrol Motor step transformer 220V/120V			Stock
2-30-000499	CAS-500 Damper Crank Arm-short	.1	.05	Stock
2-30-000506	Superior Linkage Arms-long	.18	.08	Stock
2-30-000507	Superior Linkage Swivels	.06	.03	Stock
2-40-000582	Adjustable Damper Arm	7.5	3.41	Stock
2-30-000335	Bearing Block	.75	.26	Stock
2-30-000839	Lock Collar			Stock
2-10-000144	5/16” Linkage Rod			Stock
2-10-000148	½” Drive Rod			Stock
2-45-000060	4” Handy Box			Stock
2-30-003001	Rubber Linkage Boot Gummi Bellows NEMA 4			Stock
2-40-000200	Contactor R4242 120V Coil	.6	.27	Stock
2-40-000202	Contactor R4243 120V Coil	.5	.23	Stock
Nexus Linkageless Modulation				
2-40-000557	Flame/Temperature Control Module	5.5	2.5	Stock
2-40-000558	Wiring Base	2.3	1.1	Stock
2-40-000574	Display Module	1.6	.8	Stock
2-40-000553	NEMA 1 Servo NX04	2.2	1.0	Stock
2-40-000556	NEMA 4 Servo NX20-1			Stock
2-40-000811	Temperature Sensor	.9	.4	Stock

2-40-000571	220V Air Servo NX04			Stock
2-40-000572	220V Gas Servo NX04-2			Stock
5-20-000420	Small Servo/Butterfly Valve Mounting Bracket			Stock
5-20-000421	Small Servo/Butterfly Valve Adapter Shaft			Stock
5-20-000422	Air Gate Adapter to Servo			Stock
5-20-000423	0120-0600C Linkageless Modulated Air Gate			Stock
5-20-000424	Large Servo Air Gate Adapter			Stock
5-20-000425	Air Gate Center Bracket for Mounting Servo			Stock
5-20-000426	Air Gate End Bracket for Mounting Servo			Stock
5-20-000427	0080C Linkageless Modulated Air Gate			Stock
5-20-000428	0800-1400C Linkageless Modulated Air Gate			Stock
5-20-000429	Large Servo/Butterfly Valve Adapter Shaft			Stock
5-20-000430	Large Servo/Butterfly Valve Mounting Bracket			Stock
2-45-000399	Current Monitor Relay			Stock
Miscpart	Potentiometers-Servo (61-6969)			Stock
Seimens Linkageless Modulation				
2-35-001016	TAK Air Servo Adapter			
2-35-001014	TAK Gas Servo Adapter			
2-35-001018	TAK Oil Servo Adapter			
2-40-000429	Plug Set			
2-40-000430	Display Cable			
2-40-000431	120V Transformer Power Supply			
2-40-000432	Bus Cable End Clip			
2-40-000433	Air Servo Motor			
2-40-000434	Gas Servo Motor			
2-40-000435	Conduit Adapter			
2-40-000437	Display Module AZL			
2-40-000447	Bus Cable			
2-40-000449	120V Controller LMV51			
2-40-000465	Flame Detector Self Check Vertical Mounting			
2-40-000466	Infrared Scanner Bracket Vertical Mounting			
2-45-001017	Black Nylon Cord Grip			
2-20-000422	Air Gate Shaft Adapter			
2-40-000458	220V Controller LMV51			
2-40-000457	220V Transformer			
2-40-000823	RTD 3-Wire 100 ohms			
2-40-000767	58.1 Shaft			
2-40-000768	33.9 Adapter			
5-10-003053	Gas Valve Mounting Bracket			
5-20-000455	Air Servo Mounting Bracket			
5-20-000456	End Mounting Bracket			

5-20-000426	80/320/400C End Mounting Bracket			
5-10-004786	Gussett for Brackets			
2-30-000804	Scanner Bracket Side View NEMA4			
2-40-000436	Flame Detector Side View NEMA4			
FT-0080C				
5-20-00427	Linkageless Air Gate			
5-10-001792	Air Gate Mounting Assembly			
5-20-000456	End Bracket (2 Required)			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate coupling			
5-20-000455	Air Gate Center Bracket			
FT-120C – 600C				
5-20-000423	Linkageless Air Gate			
5-20-000455	Air Gate Center Bracket			
5-20-000456	End Bracket (2 required)			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-10-001702	Air Gate Mounting Assembly			
5-10-001704	Air Gate Mounting Assembly (FT-320C-400C Only)			
FT-800C				
5-20-000428	Linkageless Air Gate			
4-20-000455	Air Gate Center Bracket			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-10-001802	Air Gate Mounting Assembly			
5-20-000457	End Bracket (2 required)			
FT-1000C – 1200C				
5-20-000428	Linkageless Air Gate			
7-21-000030	Air Gate Mounting Assembly			
5-20-000455	Air Gate Center Bracket			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-20-000435	End Bracket (2 required)			
O & M Manuals				
5-60-000120	Coil Model Thermal Fluid Heater Manual (C Model)	5.5	2.5	5 days
5-60-000122	Vertical Tubeless Thermal Fluid Heater Manual (A Model)			5 days
5-60-000123	Electric Thermal Fluid Heater Manual (N Model)			5 days
5-60-000121	Unfired Steam Generator Manual			5 days
PANEL BOX COMPONENTS **Air Switch**				
2-30-000260	1910-5 Air Switch (replaces #2-30-119 1823-2) Filter	1.46	.66	Stock
2-30-000270	1910-0 Air Switch (replaces #2-30-230 1823-1) Fan	1.46	.66	Stock

Ignition Transformer				
2-40-000082	6kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000084	6kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
2-40-000086	10kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000088	10kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
Lights/Switches/Button/Relays				
2-40-000131	General Purpose Relay (Ice Cube) 700HA32A1 120V-AB	.8		Stock
2-40-000135	General Purpose Relay (Ice Cube) 700HA32A2 220V-AB	.8		Stock
2-40-000096	Base for Ice Cube Relay		.1	Stock
2-40-000843	4 Pole Relay 120V-AB			
2-40-000842	4 Pole Relay Bast			Stock
2-40-000993	PS5-RA24 power supply	.4	.2	Stock
2-45-000050	Fuel Selector Switch	.34	.15	Stock
2-45-000091	SPST Switch-mod lock	.05	.02	Stock
2-45-000212	3 Position Switch-SqD	.14	.06	Stock
2-45-000300	NO Contacts for switch	.04	.02	Stock
2-45-000269	NC Contacts for switch	.04	.02	Stock
2-40-000791	Push Button Start SqD-green	.1	.05	Stock
2-40-000793	Push Button Stop SqD-red	.1	.05	Stock
2-45-000412	Green Light SqD-120V	.08	.03	Stock
2-45-000411	Red Light SqD-120V	.08	.03	Stock
2-40-000841	700HR Time Delay Relay for Circulating Pump	.85	.34	Stock
2-40-000134	Time Delay Relay Base			Stock
2-45-000309	Primary/Stand-by Switch –2pos	.14	.06	Stock
2-40-000151	Time Delay 10 sec adjustable			
2-45-000203	Bulb S&S	.02	.01	*
2-45-000205	Green Lens only S&S	.02	.01	*
2-45-000206	Red Lens only S&S	.02	.01	*
				***Consult Factory for Lead Time**
Motor Contactors – 3 phase/120V coil – Siemens				
2-40-000878	3RT1015-1AK6 Contactor-7 amp	.8	.36	Stock
2-40-000567	3RT1016-1AK6 Contactor-9 amp	.8	.36	Stock
2-40-000642	3RT1017-1AK6 Contactor-12 amp	.8	.36	Stock
2-40-000643	3RT1025-2QB0 Contactor-17 amp	.8	.36	Stock
2-40-000644	3RT1026-1AK6 Contactor-25 amp	.8	.36	Stock
2-40-000646	3RT1035-1AK6 Contactor40 amp	.8	.36	Stock
2-40-000825	3RT1036-1AK6 Contactor-50 amp	.8	.36	Stock
2-40-000647	3RT1044-1AK6 Contactor-65 amp	.8	.36	Stock
2-40-000645	3RT1033-1AK6 Contactor-28 amp			Stock
2-40-000631	3RT1046-1AK6 Contactor-95 amp			Stock
2-40-000637	3RT1046-1AK6 Contactor			Stock
2-40-000879	3RH1921-1LA11 Aux Contactor			Stock

2-40-000648	3BR1015-2PB0 Overload-1.5-6 amp	.45	.2	Stock
2-40-000566	3BR1015-2NB0 Overload-.4-1.6 amp	.45	.2	Stock
2-40-000573	3BR1015-2SB0 Overload-3-12 amp	.45	.2	Stock
2-40-000651	3BR1025-2QB0 Overload-6-25 amp	.45	.2	Stock
2-40-000716	3BR1035-2UB0 Overload-13-50 amp	.45	.2	Stock
2-40-000656	3BR1045-2EB0 Overload-23-75 amp	.45	.2	Stock
2-40-000822	3BR1045-2EB0 Overload-25-100 amp			Stock
Panel Box Air Conditioner & Parts				
2-40-000997	Panel Box Air Conditioner	49.6	22.6	1 week
2-45-000468	5 Minute Time Delay Relay for A/C	.5	.3	Stock
2-45-000469	Relay Base for 2-45-000468	.2	.1	Stock
Stepdown Transformer				
2-40-000441	.75KVA Stepdown Transformer-480/120-50/60hz	12	5.46	1 week
2-40-000443	1.5KVA Stepdown Transformer-480/120	12	5.46	1 week
2-40-000445	1KVA Stepdown Transformer-480/120-50/60hz	12	5.46	Stock
2-40-000440	1KVA Stepdown Transformer-208/120			Stock
Pressure Gauges & Accessories				
2-30-000529	0-100 PSI Panel Pressure Gauge-heater outlet	.44	.2	Stock
2-30-000530	0-200 PSI Panel Pressure Gauge-heater inlet	.44	.2	Stock
2-30-000531	30-0-60 PSI Panel Pressure Gauge-pump suction	.38	.17	Stock
2-30-000342	0-200 PSI Liquid Filled Gauge	.56	.25	Stock
2-30-000343	0-400 PSI Liquid Filled Gauge	.56	.25	Stock
5-21-000274	Single Gauge Panel	.5	.3	Stock
5-21-000273	Dual Gauge Panel	.9	.4	Stock
5-21-000272	Triple Gauge Panel	.8	.4	Stock
2-40-001003	Stack Thermometer 9” Probe ½” NPT			
PUMPS **Allweiler Un-mounted Pumps**				
2-30-001680	NTT-32-160 w/Mechanical Seal			*
2-30-001041	NTT-32-200 w/Mechanical Seal			*
2-30-001681	NTT-40-160 w/Mechanical Seal			*
2-30-001020	NTT-40-200 w/Mechanical Seal			*
2-30-001021	NTT-50-160 w/Mechanical Seal			*
2-30-001684	NTT-50-200 w/Mechanical Seal			*
2-30-001022	NTT-50-250 w/Mechanical Seal			*
2-30-001685	NTT-65-160 w/Mechanical Seal			*
2-30-001036	NTT-65-200 w/Mechanical Seal			*
2-30-001035	NTT-65-250 w/Mechanical Seal			*
2-30-001034	NTT-80-160 w/Mechanical Seal			*
2-30-001031	NTT-80-200 w/Mechanical Seal			*
2-30-001033	NTT-80-250 w/Mechanical Seal			*
2-30-001032	NTT-100-200 w/Mechanical Seal			*

2-30-001040	NTT-100-250 w/Mechanical Seal			*
				***Long Lead Time-check with factory for delivery & impeller trim size**
Allweiler Full Size Impellers				
2-30-001051	NTT 32/160 Impeller 170mm	4.8	2.18	*
2-30-001120	NTT 40/160 Impeller 170 mm	4.98	2.26	*
2-30-001122	NTT 65/160 Impeller 170 mm	4.62	2.1	*
2-30-001123	NTT 80/160 Impeller 180 mm			*
2-30-001126	NTT 40/200 Impeller 205 mm	6.62	3.01	*
				***Long Lead Time-check with factory for delivery & impeller trim size**
ALLWEILER SPARE PARTS LIST Common Parts For: NTT-25-200;32-1 60;4200;4250;50-1 60; 50-200; 32-200; 50-250; 65-1 60; and 80-160, 65-200				
4-30-000106	Seal Kit	1.58	.72	Stock
4-30-000126	Rebuild Kit –Includes seal kit	3.12	1.42	Stock
2-30-001030	400.1 Casing Gasket-206 x 217.5 x .5 mm	.01	.0	Stock
2-30-001043	400.2 Gasket 257 x 269 x .5	.01	.0	Stock
2-30-001044	400.13 Gasket –72.5 x 88 x .5 mm	.01	.0	Stock
2-30-001045	321.4 & 321.3 Ball Bearing	.4	.18	Stock
2-30-001048	461.1 Set of Packing	.1	.05	Stock
2-30-001049	433.2 Mechanical Seal	.26	.12	Stock
2-30-001050	210.1 Shaft	4.46	2.03	Stock
2-30-001055	Complete 360 Bearing Frame	30.52	13.87	Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Common Parts For: NTT-65-250; 80-200; 80-250; 100-200; 100-250; and 125-250				
2-30-001029	400.2 Casing Gasket	.01	.0	Stock
2-30-001205	400.8 Gasket	.01	.0	Stock
2-30-001203	461.1 Set of Packing	.01	.0	Stock
2-30-001200	433.2 Mechanical Seal	.4	.18	Stock
2-30-001038	210.1 Shaft	3.0	1.36	Stock
2-30-001204	321.3 @ 321.4 Ball Bearing	1.42	.65	Stock
2-30-001058	Complete 470 Bearing Frame	53.84	24.47	Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Dean's – Un-mounted Pump-includes impeller (truck ship only – call for impeller trim size)				
2-30-002000	RA3000 1-1/2x3x8-1/2	260.0	118.0	Stock
2-30-002002	RA3000 2x3x8-1/2	316.0	126.4	Stock
2-30-002004	RA3000 3x4x8-1/2	344.0	156.0	Stock
2-30-002006	RA3000 4x6x8-1/2	390.0	177.0	Stock
Miscpart	RA3000 1.5x3x10			Stock
5-20-000400	Small Pump Guard			Stock
5-20-000402	Large Pump Guard			Stock
2-30-002218	#4 Impeller Key	.02	.01	Stock
2-30-002219	#12 Impeller Bolt	.04	.02	Stock
2-30-002220	#12A Impeller Washer	.14	.07	Stock

2-30-002221	#13 Mech Seal Gland	1.8	.9	Stock
2-30-002222	#25A Thrust Bearing	1.5	.7	Stock
2-30-002223	#28 Bearing End Cover	5.7	2.6	Stock
2-30-002224	#29 Pump Shaft	9.5	4.4	Stock
2-30-002225	#31 Thrust Bearing Locknut	.3	.2	Stock
2-30-002226	#31A Thrust Bearing Washer	.1	.05	Stock
2-30-002227	#75 Snap Ring	.02	.01	Stock
2-30-002228	#76 Grease Seat – front	.1	.05	Stock
2-30-002229	#76A Grease Seat – rear	.1	.05	Stock
2-30-002230	#77B Bearing End Cover Gasket			Stock
2-30-002231	#95 A/B Mech Seal	.5	.23	Stock
2-30-002232	#180 Radial Bearing Cartridge	3.8	.18	Stock
2-30-002233	#325 Seal Gland Gasket			Stock
2-30-002257	Seal Gland			1 week
2-30-002258	Lip Seal			1 week
2-30-002259	Gland Gasket			1 week
2-30-002256	Collar & Set Screws			1 week
2-30-002252	#6A Casing Ring 1x3x8 ½ & 1 1/2x3x8 ½			Consult factory
2-30-002253	#6A Casing Ring 2x3x8 ½			Consult factory
2-30-002254	#6A Casing Ring 3x4x8 ½			Consult factory
2-30-002255	#6A Casing Ring 4x6x8 ½			Consult factory
2-30-002234	#325A Seal Gland Gasket			Stock
2-30-002242	#365 Mech Seal Retainer	.2	.1	Stock
2-30-002251	#3 Impeller 1x3x8 ½			1 week
2-30-002235	#3 Impeller 1-1/2x3x8-1/2	8.7	4.0	Stock
2-30-002236	#3 Impeller 2x3x8-1/2	10.3	4.7	Stock
2-30-002237	#3 Impeller 3x4x8-1/2	11.1	5.1	Stock
2-30-002238	#3 Impeller 4x6x8-1/2	12.6	5.8	Stock
Miscpart	#3 Impeller 1.5x3x10			Stock
2-30-002239	#77 Casing Gasket	.04	.02	Stock
2-30-002240	6322595 Grease	.2	.1	Stock
8-00-000046	Shaft Sleeve Guide	1.0	.05	Stock
8-00-000047	Carbon Sleeve Removal Tool	1.6	.8	Stock
Dean's – kits				
4-30-000130	Start Up kit for Deans RA3000 Series Pumps			Stock
4-30-000140	1 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock
4-30-000141	1 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000142	1 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000143	1 Year Service Kit for Deans RA3000 4x6x8.5			Stock
4-30-000150	2 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock

4-30-000151	2 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000152	2 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000153	2 Year Service Kit for Deans RA3000 4x6x8.5			Stock
SIHI Un-mounted Pumps – includes impeller (call for impeller trim size)				
2-30-001000	ZTN 3216 w/mech seal	58.0	26.36	Consult factory
2-30-001002	ZTN 3220 w/mech seal	84.0	38.18	Consult factory
2-30-001004	ZTN 4016 w/mech seal	73.0	33.18	Consult factory
2-30-001006	ZTN 4020 w/mech seal	84.0	38.18	Consult factory
2-30-001007	ZTN 5013 w/mech seal	90.0	40.91	Consult factory
2-30-001008	ZTN 5016 w/mech seal	90.0	40.91	Consult factory
2-30-001010	ZTN 5020 w/mech seal	95.0	43.18	Consult factory
2-30-001012	ZTN 6516 w/mech seal	92.0	41.82	Consult factory
2-30-001014	ZTN 6520 w/mech seal	89.0	40.45	Consult factory
2-30-001016	ZTN 8016 w/mech seal	107.0	48.64	Consult factory
2-30-001018	ZTN 8020 w/mech seal	115.0	52.27	Consult factory
2-30-001019	ZTN 10020 w/mech seal	152.0	69.09	Consult factory
SIHI Impellers				
2-30-000589	8020-30 Impeller 210 mm	8.08	3.67	Consult factory
2-30-000590	5016-30 Impeller 170 mm	3.56	1.62	Consult factory
2-30-000591	3220-30 & 4020 Impeller 210 mm	5.52	2.51	Consult factory
2-30-000693	5020-30 Impeller 210 mm	6.14	2.79	Consult factory
2-30-000694	4016-30 Impeller 170 mm	3.94	1.79	Consult factory
Miscpart	10020 Impeller			Consult factory
Pump serial numbers must be given to factory to verify availability & pricing **Common parts for the following models: 3213, 3216, 3220, 4013, 4016, 4020, 5013, 5016, 5020, 6513, 6516, 6520 and 8016**				
4-30-000108	Mech seal kit (3213 to 8016)	1.7	.8	Stock
4-30-000110	Pump repair kit w/ mech seal (3213 to 8016)	2.0	1.0	Stock
4-30-000100	Radial seal kit (3213 to 8016)	1.34	.61	Stock
4-30-000120	Pump rebuild kit w/rad seals (3213 to 8016)	2.32	1.05	Stock
2-30-001013	Item 500-Mechanical Seal	2.0	1.1	Stock
2-30-000580	Item 341-Sleeve Bearing	.44	.2	Stock
2-30-000583	Item 200-Shaft (includes # 256, 257, 260, 286, 292)	2.94	1.34	Stock
2-30-000585	Item 426-Rad Seal –7 required	.1	.05	Stock
2-30-000451	Item 140-Gasket	.01	0.0	Stock
2-30-000588	Item 81' –'O' Ring	.01	0.0	Stock

2-30-000594	Item 221-Ball Bearing Cover	.5	.23	Stock
2-30-000597	Item 230-Ball Bearing	.5	.23	Stock
2-30-000598	Item 292-Lockwasher	.01	0.0	Stock
2-20-000190	Item 266-Spacer	.01	0.0	Stock
2-12-000067	Item 80-13 Series Casing Gasket	.12	.05	Stock
2-12-000098	Item 80-16 Series Casing Gasket	.18	.08	Stock
2-12-000099	Item 80-20 Series Casing Gasket			Stock
2-60-000153	EP#2 Grease	10.14	4.61	Stock
Common parts for the 8020 and 10020 models				
4-30-000112	Seal Kit w/mech seal	1.7	.8	Stock
4-30-000113	Pump Repair Kit w/mech seal	4.1	1.9	Stock
2-30-001015	Item 500-Mechanical Seal	.4	.2	Stock
4-30-000102	8020 Seal Kit w/radial seals	1.38	.63	Stock
4-30-000122	8020 Rebuild Kit w/radial seals	3.8	1.73	Stock
2-30-000451	Item 140-Gasket	.1	0.0	Stock
2-30-000581	Item 230-Ball Bearing	.98	.45	Stock
2-30-000593	Item 221-Bearing Cover	.1	.05	Stock
2-30-000582	Item 200-Shaft	7.5	3.41	Stock
2-30-000584	Item 426-Rad Seal-7 required	.1	.05	Stock
2-30-000592	Item 241-Sleeve Bearing	.66	.3	Stock
2-12-000099	Item 80-Casing Gasket	.0		Stock
2-12-000116	Item 80-Gasing Gasket for ZTN 10020	.02	.01	Stock
2-30-000599	Item 81-'O' Ring	.0		Stock
2-60-000153	EP#2 Grease	10.14	4.61	Stock
Pump/motor coupling parts				
2-30-000707	E4 24mm Rexnord Hub	1.8	.82	Stock
2-30-000705	E4 1-1/8" Rexnord Hub	1.45	.66	Stock
2-30-000706	E4 1-3/8" Rexnord Hub	1.22	.55	Stock
2-30-000710	E4 1-5/8" Rexnord Hub	.96	.44	Stock
2-30-000708	E4 Elastomer Element	1.36	.62	Stock
2-30-000704	E5 24 mm Rexnord Hub	2.84	1.29	Stock
2-30-001072	E5 32 mm Rexnord Hub	2.4	1.09	Stock
2-30-000712	E5 1-1/8" Rexnord Hub	2.52	1.15	Stock
2-30-000703	E5 1-3/8" Rexnord Hub	2.5	1.14	Stock
2-30-000702	E5 1-5/8" Rexnord Hub	2.14	.97	Stock
2-30-000713	E5 1-7/8" Rexnord Hub	1.64	.75	Stock
2-30-000714	E5 Elastomer Element	2.14	.97	Stock
2-30-000716	E10 24 mm Rexnord Hub	4.08	1.85	Stock
2-30-001073	E10 32 mm Rexnord Hub	5.0	2.27	Stock
2-30-000718	E10 1-5/8" Rexnord Hub	3.4	1.55	Stock
2-30-000717	E10 1-7/8" Rexnord Hub	3.04	1.38	Stock
2-30-000711	E10 2-1/8" Rexnord Hub	3.5	1.59	Stock

2-30-000715	E10 Elastomer Element	2.86	1.3	Stock
2-30-000752	E20 1-1/8" Rexnord Hub			Stock
2-30-000821	E20 32 mm Rexnord Hub	7.86	3.57	Stock
2-30-000823	E20 1-7/8" Rexnord Hub	7.86	3.57	Stock
2-30-000824	E20 2-1/8" Rexnord Hub	7.86	3.57	Stock
2-30-000822	E20 Elastomer Element	2.86	1.3	Stock
Pump bases				
5-30-005000	12"x40" Base			Stock
5-30-005002	15"x48" Base			Stock
5-30-005004	18"x48" Base			Stock
SAFETY RELIEF VALVES **Thermal fluid safety valves**				
2-30-000544	Kunkle Safety Valve ¾" 100 psi-920	3.92	1.78	Stock
2-30-000545	Safety Valve 1" 100 psi-920	5.72	2.6	Stock
2-30-000546	Safety Valve 1-1/4" 100 psi-920	8.6	3.91	Stock
2-30-000547	Safety Valve 1-1/2" 100 psi-920	15.04	6.84	Stock
2-30-000548	Safety Valve 2" 100 psi-920			Stock
Thermal fluid safety valve (flanged)				
2-30-000609	Kunkle safety valve ¾" 100 psi-920-300# flanged	11.3	5.2	Stock
2-30-000610	Kunkle safety valve 1" 100 psi-920-300# flanged	14.6	6.7	Stock
2-30-000611	Kunkle safety valve 1-1/4" 100 psi-920-300# flanged	23.5	10.7	Stock
2-30-000612	Kunkle safety valve 1-1/2" 100 psi-920-300# flanged	34.0	15.5	Stock
2-30-000613	Kunkle safety valve 2" 100 psi-920-300# flanged Above used on heater #3117C & Up (2001)	45.0	20.5	Stock
Kunkle N2 safety valves – expansion tank				
2-30-000637	1" SRV 15 PSI			
2-30-000636	¾" SRV 15 PSI			
2-30-000639	1 ½" SRV 15 PSI			
2-30-000638	1 ¼" SRV 15 PSI			
SKID COMPONENTS **Worchester Valves**				
2-30-000534	¼" Threaded Ball Valve	1.54	.07	Consult factory
2-30-000536	¾" Ball Valve-Two Way	1.98	.9	Consult factory
2-30-000537	1" Ball Valve-Two Way	3.82	1.74	Consult factory
2-30-000538	1-1/4" Ball Valve-Two Way	5.1	2.32	Consult factory
2-30-000539	1-1/2" Ball Valve-Two Way	7.46	3.39	Consult factory
2-30-000540	2" Ball Valve-Two Way	10.1	4.59	Consult factory
2-30-000897	½" Ball Valve w/Actuator	7.08	3.22	Consult factory
2-30-000896	1" Ball Valve w/Actuator	14.0	6.45	Consult factory
2-30-000899	1-1/2" 3-Way Diverting Valve w/Actuator	22.14	10.06	Consult factory

2-30-000898	2” 3-Way Diverting Valve w/Actuator	25.84	11.75	Consult factory
2-30-001300	1-1/4” Valve Repair Kit	.16	.07	Consult factory
2-30-001301	1-12” Valve Repair Kit	.2	.09	Consult factory
2-30-001303	1039 Actuator Repair Kit	.18	.08	Consult factory
2-30-001304	2039 Actuator Repair Kit	.1	.08	Consult factory
2-30-001305	Series 1039 Actuator (1” and smaller)	.06	.05	Consult factory
2-30-001313	1-1/4” S Ring	.02	.03	Consult factory
2-30-001314	1-1/2” S Ring	.02	.01	Consult factory
2-30-001315	2” S Ring		.01	Consult factory
Dezurik Valves				
2-30-000885	1.5” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000820	2” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000886	3” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000882	3” Dezurik Valve Repair Kit			Consult factory
2-30-000880	2” Dezurik Valve Repair Kit			Consult factory
2-30-000883	1.5” Dezurik Valve Repair Kit	.2	.1	Consult factory
2-30-001261	ES10 Actuator Rebuild Kit	.2	.1	Consult factory
2-30-001260	ES20 Actuator Rebuild Kit	.16	.07	Consult factory
2-30-001276	1” Valve Actuator ES10-6			Consult factory
SteamPac Components				
2-40-000420	Fulton Pump Relay –120V	.5	.23	Stock
2-40-000422	Base for Fulton Pump Relay (8 pin)	.25	.11	Stock
2-40-000403	IDIDO Relay	2.0	.91	Stock
2-40-000202	Motor Starter R4243 – 30 Amp	.52	.24	Stock
2-40-000421	120V Water Level Relay			Stock
2-40-000423	Base for 120V Water Level Relay (11 pin)			Stock
2-40-000229	Pressuretrol L404A1396	2.0	.91	Stock
2-12-000004	Handhole Gasket	.04	.02	Stock
2-12-000007	5/8”x9-1/4” Gauge Glass	.2	.09	Stock
2-12-000019	5/8” Rubber Gasket	.004	0.0	Stock
2-12-000020	5/8” Brass Gasket	.002	0.0	Stock
2-30-000149	½” Water Gauge Valve w/ ball checks	1.5	.68	Stock
2-30-000047	½” Tri-cock	.42	.19	Stock
2-20-000017	Low Water Cutoff Probe-17-1/8” – cut to any length	.5	.23	Stock
2-20-000010	Low Water Probe	.5	.23	Stock
2-20-000012	High Water Probe	.5	.23	Stock

2-30-000029	½" Float Valve	.72	.33	Stock
2-30-000028	¾" Float Valve	.76	.35	Stock
2-30-000124	4 ½" Float Ball only	.6	.27	Stock
2-12-000534	½" Float Valve Disc	.01	0	Stock
2-12-000535	¾" Float Valve Disc	.01	0	Stock
2-30-000332	300# Steam Gauge	.5	.23	Stock
Strainer Parts				
2-30-000870	60 Mesh Strainer Basket-2" Keckley	.4	.18	Stock
2-30-000871	60 Mesh Strainer Basket-2-1/2" Keckley	.38	.17	Stock
2-30-000872	60 Mesh Strainer Basket-3" Keckley	.66	.3	Stock
2-30-000873	60 Mesh Strainer Basket-4" Keckley	.75	.34	Stock
2-30-000847	60 Mesh Strainer Basket-6" Keckley	.75	.34	Stock
2-30-000829	60 Mesh Strainer Basket-8" Keckley	.8	.37	Stock
2-12-000120	Gasket for 2" Keckley Strainer	.04	.02	Stock
2-12-000121	Gasket for 2-1/2" Keckley Strainer	.04	.02	Stock
2-12-000122	Gasket for 3" Keckley Strainer	.04	.02	Stock
2-12-000123	Gasket for 4" Keckley Strainer	.14	.06	Stock
2-30-000878	Gasket for 6" Keckley Strainer	.14	.06	Stock
2-30-000830	Gasket for 8" Keckley Strainer	.14	.06	Stock
2-30-000627	Strainer –4" Keckley 150# Flanged	62.2	28.3	Stock
2-30-000874	Strainer –5" Keckley 150# Flanged			Stock
2-30-000875	Strainer –6" Keckley 150# Flanged	68.5	34.3	Stock
2-30-000828	Strainer –8" Keckley 150# Flanged	999.0	454.0	Stock
2-30-000808	Strainer –2 ½" Titan			
2-30-000809	Strainer –3" Titan			
2-30-000810	Strainer –4" Titan			
2-12-000135	Gasket for 2 ½" Titan Strainer			
2-12-000136	Gasket for 3" Titan Strainer			
2-12-000137	Gasket for 4" Titan Strainer			
Notes: SIHI & Allweiler pump flanges use 150# - 4 bolt, Deans pump flanges use 300#				

Standard Warranty for Fulton Thermal Fluid Heaters

Warranty Valid for Models FT-A, FT-C, FT-S, FT-N, FT-HC

One (1) Year (12 Month) Material and Workmanship Warranty
The pressure vessel is covered against defective material or workmanship for a period of one (1) year from the date of shipment from the factory. Fulton will repair or replace F.O.B. factory any part of the equipment, as defined above, provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by Fulton. The commissioning agency must also successfully complete and return the equipment Installation and Operation Checklists to Fulton's Quality Assurance department. This warranty covers any failure caused defective material or workmanship.

Parts Warranty
Fulton will repair or replace F.O.B. factory any part of the equipment of our manufacture that is found to be defective in workmanship or material within one (1) year of shipment from the factory provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by both Fulton and the component manufacturers and the commissioning agency has successfully completed and returned the equipment Installation and Operation Checklists to Fulton's Quality Assurance department.

General
Fulton shall be notified in writing as soon as any defect becomes apparent. This warranty does not include freight, handling or labor charges of any kind.

These warranties are contingent upon the proper sizing, installation, operation and maintenance of the boiler and peripheral components and equipment. Warranties valid only if installed, operated, and maintained as outlined in the Fulton Installation and Operation Manual.

No Sales Manager or other representative of Fulton other than the Quality Manager or an officer of the company has warranty authority. Fulton will not pay any charges unless they were pre-approved, in writing, by the Fulton Quality Manager.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Fulton shall in no event be liable for any consequential or incidental damages arising in any way, including but not limited to any loss of profits or business, even if the Fulton Companies has been advised of the possibility of such damages. Fulton's liability shall never exceed the amount paid for the original equipment found to be defective.

To activate the warranty for this product, the appropriate commissioning sheets must be completed and returned to the Fulton Quality Assurance department for review and approval.

Fulton

9/10/09

Section 6

Section 6 – Product Specs & Data

Fulton Fuel Fired Coil Design Thermal Fluid Heat Transfer Systems

1. General Description

a) Contractor shall furnish and install a_____ fired _____BTU/Hr. thermal fluid heat transfer system. The system shall be "Fulton" as manufactured by Fulton Thermal Corporation, Pulaski, New York.

b) The system shall be a complete package including a vertical coil design type heater; combination expansion deaerator thermal buffer tank to allow for expansion of thermal fluid during heat up to operating temperature and to prevent oxidation of the thermal fluid during operation, even when tank is vented to atmosphere; for operating temperatures up to 650°F complete with instrumentation and controls as specified in Section 3. Flanged inlet and outlet shall be located at front end of the unit.

2. Heater Size & Operating Temperature

a) The heater net input shall not exceed _____ BTU/Hr. while producing a minimum of _____ BTU/Hr. output as measured at the thermal fluid outlet. The heater shall be supplied complete with control panel and all required safety devices for a maximum operating temperature of _____°F (standard 650°F max). It shall have a flow rate of _____GPM and a motor voltage of _____ with a control voltage of _____.

3. Heater Design

a) The heater shall be of a vertical, helical coil self venting design, and the pressure vessel coil construction shall be carbon steel ASME SA106B, Schedule 40 or equal, with a design pressure of 200 PSI standard at 700°F. Heater will be per ASME Code Section I stamped at 150 PSIG MWP trimmed at 100 PSI unless otherwise specified. Test pressure will be per ASME Code Section I. Minimal refractory lining shall be supplied in heater combustion chamber to avoid thermal inertia and overheating of the thermal fluid should a pump or power failure occur. IT shall be completely factory piped, wired, and tested. Thermal efficiency shall be 85% or higher on fuel LHV.

b) The shell, coil and burner are surrounded by the preheater jacket. This jacket is steel welded construction with an integral floor plate, bolted top cover to facilitate coil removal, access panels for air chamber inspection and has an aluminum inner air baffle. This preheater obviates the requirement for insulation of the

heater and simultaneously boosts thermal efficiency by preheating incoming combustion air.

c) The following instrumentation/controls/safety devices shall be supplied as a minimum requirement:

1. High temperature safety switch interlock at heater outlet shutdown and alarm signal at terminal strip-Yokogawa
2. Heater operation interlock with circulation pump.
3. Low differential pressure switch to shut down the pump and heater due to a low flow condition - U.E.
4. Thermal fluid temperature control –Siemens
5. High System Pressure Switch for Complete Shutdown – Danfoss or Honeywell
6. Low System Pressure Switch for Complete Shutdown – Danfoss or Honeywell
7. Expansion Tank Low Level Switch for Shutdown - Square D
8. Heater Outlet Pressure Gauge - Ashcroft
9. Heater Inlet Pressure Gauge - Ashcroft
10. Pump Supply (Vacuum) Gauge - Ashcroft
11. Flame safety relay – Siemens
12. Magnetic starters for burner and pump motors
13. Three Position Selector Switch: off/pump on/heater on
14. Four Indicating Lights:
    1. Pressure & Flow
    2. Heat Demand
    3. Main Flame
    4. Alarm
15. ASME Certified Safety Relief Valve -Kunkle Model 920
16. Non-fused disconnect
17. Single source power connection

4. Burner

a) The burner shall be manufactured and matched to the heater by the heater manufacturer to fully assure single-source system responsibility. The burner shall be forced draft and shall be an integral part of the heater, but designed for easy removal and cleaning of the burner. Burner control method shall be On/Off, 3:1 modulation. Burner control shall be completely automatic, including flame supervision, fluid flow monitoring, and heater cycling.

5. Combination Expansion/Deaerator Thermal Buffer Tank Size

a) The combination expansion/deaerator thermal buffer tank shall have _____gallon capacity and be supplied complete with liquid level switch. It shall be suitable for a maximum total system fluid content of _____ gallons, including heater and expansion/deaerator tank capacities (based on a _____% expansion rate of the hot oil – to be verified by the client).

6. Combination Expansion/Deaerator Thermal Buffer Tank Design

a) The combination expansion/deaerator thermal buffer tank will be constructed of carbon steel. It shall be supplied with expansion tank liquid level switch and 300# ANSI flanged connections. The tank may be built to ASME Code Section VIII Division I upon request.

7. Thermal Fluid Circulating Pump Size

a) The thermal fluid circulating pump shall be air cooled with mechanical seal design for 650^{o}F maximum operating temperature, _____ GPM at _____ PSI, _____ HP Motor, _____ RPM motor, complete with motor starter, _____ voltage. Water cooled pumps will be supplied upon request or for operating temperatures above 650^{o} F.

8. Thermal Fluid Circulating Pump Design

a) The thermal fluid circulating pump shall be of centrifugal design, with a mechanical seal air cooled for temperatures up to 650°F or water cooled for operating temperatures above 650°F and shall be supplied complete with motor starter for proper motor HP, voltage and cycles.

9. Tests

a) Shall include a hydrostatic test of the pressure vessel in the presence of an inspector having a National Board Commission. He shall certify a Data Report which shall be delivered with the heater as evidence of ASME Code compliance. In addition to ASME symbol, the heater shall bear a National Board Registration Number.

b) Full electrical checks will be performed including testing of all controls and circuitry.

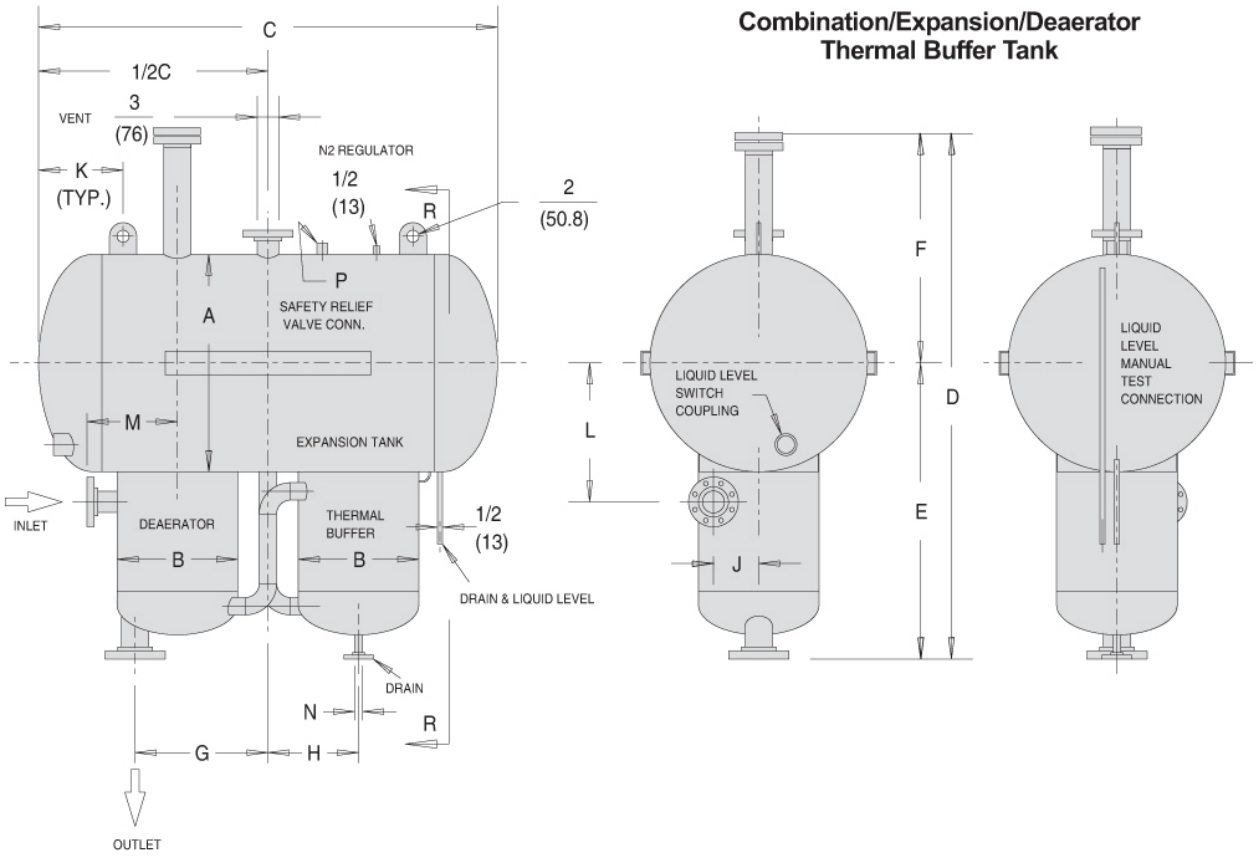
c) Test fire with combustion check.

10. Operating Manual

a) Instructions for installation, operation, and maintenance of the heat transfer system shall be contained in a manual provided with each unit.

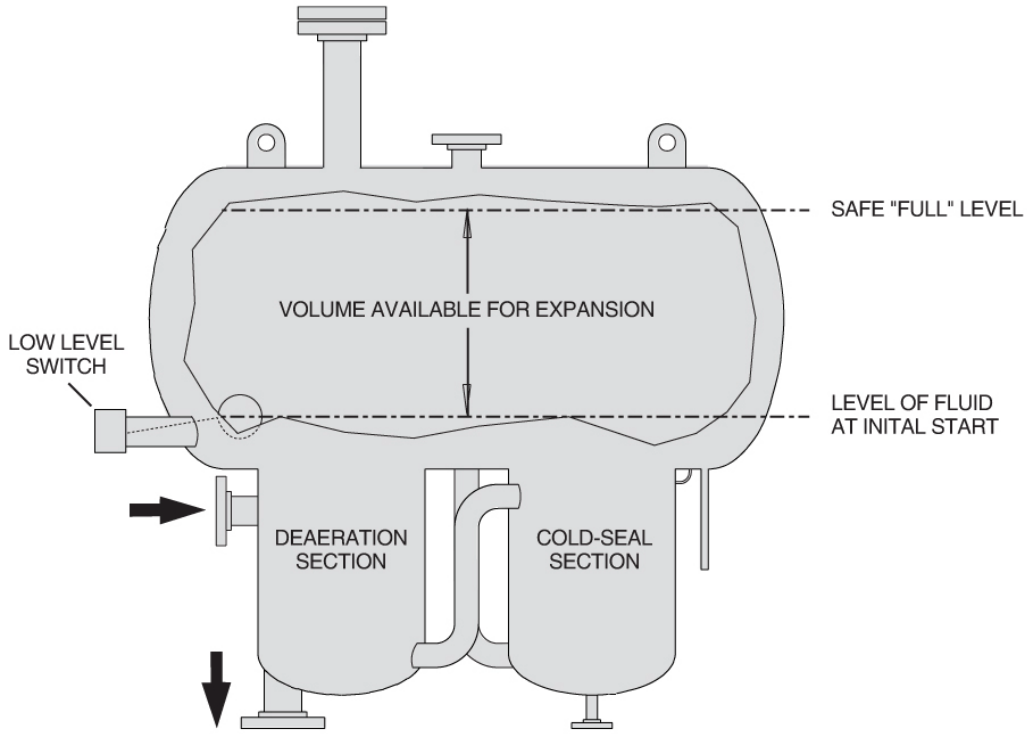
b) A complete wiring diagram, corresponding to the equipment supplied, shall be part of the manual and one shall also be affixed to the inside of the heater's panel box.

Dimensions and Sizing Instructions of the Fulton Combination Expansion/Deaerator/Thermal Buffer Tank Models FT-200-L to FT-5000-L



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16 1/16 (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12 15/16 (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14 15/16 (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7 1/16 (202)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31 1/16 (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14 15/16 (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33 3/16 (843)	24 (610)	9 15/16 (252)	15½ (394)	28 (710)	18 15/16 (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅝ (1387)	32 1/16 (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18 15/16 (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)



Developed specifically for thermal fluid system use, the Fulton Combination/Deaerator/Expansion/Thermal Buffer Tank is a patented design. The unique combination of the operation of these three vessels in one results in numerous advantages including: pipework simplification, protection of thermal fluid from oxidation, ease of installation, and continuous deaeration of fluid, avoiding pump cavitation.

Expansion Section:

The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. Additional expansion section features include a liquid level switch and manual fluid levels test connections. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Manual low and high fluid level test connections are always provided.

Deaerator Section:

At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation.

Thermal Buffer Section:

A system of interconnecting pipework in the thermal buffer tank section prevents the movement of any oil, that has not cooled sufficiently, into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the atmosphere.

Sizing the Tank for the System:

Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the tope of the tank to avoid spillage or overflow.

At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely, and the expansion section must be filled to a level of 4" to "make" the low level switch.

The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-100-L	35	9	25	100
FT-200-L	52	25	46	184
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

Example: A System contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it's 25%). 200 gal. x 1.25=250 gal. 250-200=50 gal. expansion. The FT-200-L has only 46 gal. available for expansion, so the correct selection is FT-500-L.

Specifications-Coil Design Thermal Fluid Heater

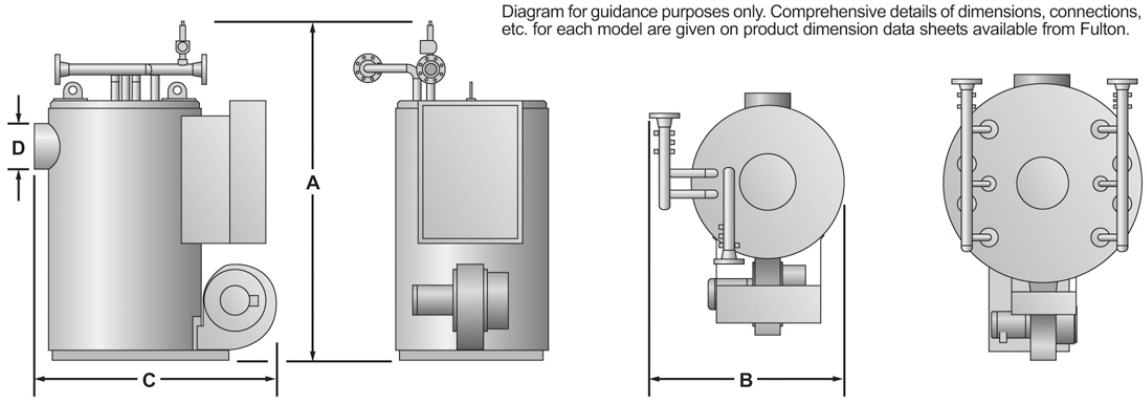
Model FT-C	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heat Output											
1000 BTU/HR	800	1,200	1,600	2,400	3,200	4,000	6,000	8,000	10,000	12,000	14,000
1000 KCAL/HR	200	300	400	600	800	1,000	1,500	2,000	2,500	3,000	3,500
Thermal Fluid Content											
GAL	10	21	19	31	68	76	132	171	290	383	460
LITERS	38	80	72	116	258	288	498	648	1,097	1,448	1,741
Recommended Flow Rate											
GPM	50	75	100	150	250	250	375	500	615	730	800
M3/HR	11.4	17	22.7	34	56.8	56.8	85.2	113.6	139	167	182
Typical Circulating Pump Motor											
HP	10	10	15	15	20	20	30	40	50	50	60
KW	7.5	7.5	11.2	11.2	14.9	14.9	22.5	29.5	37.3	37.3	45
Typical Burner Motor											
HP	1.5	3	3	3	5	5	7.5	15	15	20	20
KW	1.1	2.2	2.2	2.2	3.7	3.7	5.6	11.2	11.2	15	15
Fuel Consumption @ Full Output No.2 Oil											
GPH	7.1	10.7	14.3	21.4	28	35.3	53	69.7	87.1	104.5	122
LITER/HR	27	40.6	54.1	81	108.8	136	201	263.7	329.6	395.5	461.5
Natural Gas											
FT3/HR	998	1,498	1,998	2,999	4,000	4,997	7,498	9,997	12,496	14,998	17,500
M3/HR	38.3	42.4	56.5	84.9	113.2	141.5	212.3	283	353.8	424.6	495.5

- Voltage 3 Phase for Burner and Pump - Each unit has an incorporated stepdown transformer.
- Fuel up to No. 6 Oil Available for Large Units.
- Efficiency up to 80% Minimum Based on High Heating Value of the Fuel (No. 2 Oil @ 140,000 BTU/GHHV; Natural Gas @ 1000 BTU/ft3HHV.
- Modulation 3 to 1 Turn Down Ratio. Optional on FT-0080, 0120, and 0160-Standard on all others.
- Circulating pump motor sizes based on standard pressure (55 PSIG) and viscosity 1 cs, specific gravity 0.7, with 25-37 PSID available head for installation.

Dimensions-Coil Design Thermal Fluid Heater

Model FT-C	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heater Inlet/Outlet Connections											
IN	1.25	5	2	2.51	3	3	4	4	6	6	6
MM	32	38	51	64	76.3	76	102	102	152	152	152
(A) Overall Height											
IN	73.7	80.7	80.6	89.7	100.6	112.4	143.6	143	146.5	146.4	163.1
MM	1,872	2,050	2,046	2,278	2,556	2,856	3,648	3,632	3,721	3,718	4,144
(B) Overall Width											
IN	31.6	34.4	45.9	50.1	49.3	49.3	63.4	70.5	95	108.4	108.4
MM	803	873	1,165	1,273	1,252	1,252	1,611	1,791	2,413	2,753	2,753
(C) Overall Depth											
IN	46.2	60.6	60.6	66.6	80.6	80.6	88.1	107.75	135.1	152.9	152.9
MM	1,173	1,540	1,540	1,691	2,046	2,046	2,237	2,736	3,432	3,882	3,882
(D) Flue Outlet Diameter											
IN	10	10	10	12	14	14	18	20	20	22	22
MM	254	254	254	305	356	356	457	508	508	559	559
Recommended Vertical Stack Diameter											
IN	10	12	12	14	18	18	22	24	24	26	26
MM	254	304	304	356	457	457	558	609	609	661	661
Approximate Dry Weight											
LB	1,500	2,100	2,550	3,400	5,300	5,300	8,250	11,450	19,250	21,700	23,000
KG	700	950	1,150	1,550	2,400	2,400	3.750	5,200	8,750	9,850	10,455

Diagram for guidance purposes only. Comprehensive details of dimensions, connections, etc. for each model are given on product dimension data sheets available from Fulton.



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